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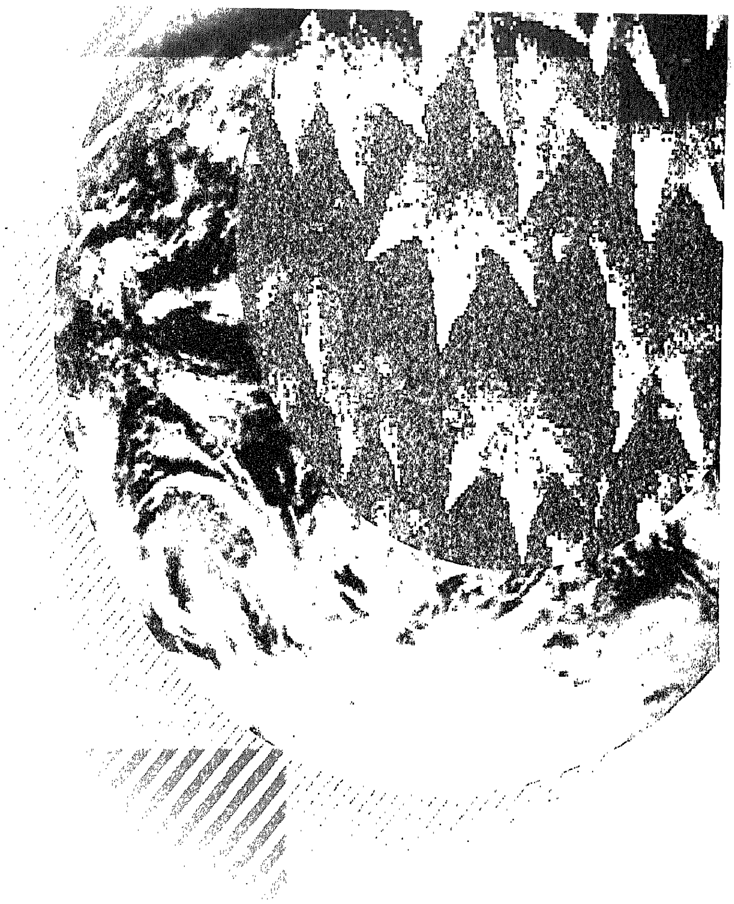

Volume 1

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TIDEE

TERI Information Digest on Energy and Environment

ENVIS Centre on
Renewable Energy and Environment

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Ministry of Environment and Forests
Government of India

About TIDEE

Why is TIDEE published? How is its purpose being fulfilled?

TIDEE (TERI Information Digest on Energy and Environment) aims to keep policy-makers, scientists, and technologists abreast of the latest developments in the fields of energy, local and global environment, and sustainable development.

TIDEE incorporates and builds on the strengths of all the abstracts journals TERI has published to date, beginning with *Energy Digest* (1982 to 1990) and *Indian Energy Abstracts* (1985 to 1990), which merged to form TIDE (TERI Information Digest on Energy, 1991 to 2001). ASSET (Abstracts of Selected Solar Energy Technology) merged with TIDE in 1999. Whereas these journals covered energy issues, TISGLOW (TERI Information Service on Global Warming, 1990 to 1998) focused on global warming, GER (Global Environmental Review, 1999 to 2001) focused on climate change, and TIMES (TERI Information Monitor on Environmental Science, 1996 to 2001) focused on the environment. In all, up to 2001, we published close to 10 000 abstracts in these journals. TIDEE continues the tradition and consolidates in one journal current information from all over the world on energy, environment, and sustainable development.

To serve the readers of TIDEE, TERI's Library and Information Centre regularly scans (1) more than 600 periodicals; (2) several hundred other documents such as technical reports, newspapers, patents and standards, government gazettes, conference proceedings, and books; (3) about a dozen abstracting and indexing services; (4) other electronic resources such as CD-ROMs; and (5) the World Wide Web including web sites, discussion groups, and mailing lists. Relevant information from all these sources is further scrutinized by subject specialists. The text thus collected and refined is then meticulously copy-edited to international standards and presented in a specially-designed user-friendly format.

Each issue of TIDEE contains a few articles, about 250 abstracts, a few newsbriefs and digests of web sites, and announcements of conferences, patents, standards, government notifications, and so on.

The project team of TIDEE is guided by a distinguished editorial board chosen to represent conventional and non-conventional energy sources, local and global environmental issues, and broad issues of sustainable development. Besides, the project team is also guided by experts in information science and publishing.

How often is TIDEE published?

TIDEE is published four times a year, in March, June, September, and December. The four issues make up a volume. The issue dated March 2002 marks the first issue of TIDEE.

How to subscribe and how much does it cost?

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About TERI

A dynamic and flexible organization with a global vision and a local focus, TERI was established in 1974. While in the initial period the focus was mainly on documentation and information dissemination activities, research activities in the fields of energy, environment, and sustainable development were initiated towards the end of 1982. The genesis of these activities lay in TERI's firm belief that efficient utilization of energy, sustainable use of natural resources, large-scale adoption of renewable energy technologies, and reduction of all forms of waste would move the process of development toward the goal of sustainability.

A unique developing-country institution, TERI is deeply committed to every aspect of sustainable development. From providing environment-friendly solutions to rural energy problems to helping shape the development of the Indian oil and gas sector; from tackling global climate change issues across many continents to enhancing forest conservation efforts among local communities; from advancing solutions to growing urban transport and air pollution problems to promoting energy efficiency in the Indian industry, the emphasis has always been on finding innovative solutions to make the world a better place to live in. However, while TERI's vision is global, its roots are firmly entrenched in Indian soil. All activities in TERI move from formulating local- and national-level strategies to suggesting global solutions to critical energy and environment-related issues. It is with this purpose that TERI has established regional centres in Bangalore, Dona Paula (Goa), and Guwahati, and a presence in Japan, Malaysia, Russia, and the United Arab Emirates. It has set up affiliate institutes: TERI–NA (Tata Energy and Resources Institute–North America) in Washington, DC, USA, and TERI Europe in London, UK.

TERI hosts the annual Delhi Sustainable Development Summit, which is swiftly gathering momentum as a major forum for the convergence of globally renowned leaders and thinkers dealing with the issue of sustainability.

With a staff strength of over 500, drawn from multidisciplinary and highly specialized fields, offices and regional centres equipped with state-of-the-art facilities, and a diverse range of activities, TERI is the largest developing-country institution working to move human society towards a sustainable future. Well on its way to becoming a cybercorp, TERI makes effective use of the latest developments in modern information technology in both its in-house and outreach activities.

TERI lays great emphasis on training, capacity building, and education. In 1999, it set up the TERI School of Advanced Studies, recognized as a deemed university by the University Grants Commission, India. The School is evolving as a research university, offering doctoral programmes in bioresources, biotechnology, energy, environment, and regulatory and policy studies.

Having celebrated its silver jubilee in February 2000, TERI is now poised for future growth, driven by a global vision and outreach, with a philosophy that emphasizes and assigns primacy to enterprise in government, industry, and individual actions.

TIDE

TERI Information Digest on Energy

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C L Gupta

India's Energy Security: twenty five years of endeavour towards a solar future*

TERI Information Digest on Energy and Environment 1(2): 195-207

Abstract

The current scenario for energy and water in India is rather grim, with no relief in sight in future without drastic changes in the strategies of production, distribution and end-use conservation, and efficiency. The financial burden of the energy sector is crippling for the nation and will be so for the user, when the administered prices are abolished. Merely stressing on increasing the generation is untenable technically, environmentally, and financially even on a short-term basis. Can solar energy mitigate the misery and if so to what fraction and at what cost and effort? What has been done in renewable energy during the last 25 years and what more needs to be done within the next 10 years? Changes are needed not only in the commonplace strategy but also in attitudes towards reducing wastage in the use of resources and their end forms. A national energy policy including all sources should be in place in an integrated manner and not just by bits and pieces as of now.

Introduction

India's energy scenario is rather scary with little chance of improvement in sight. Some of the reasons are a culture of wasteful and indifferent uses, conflicting policy decisions e.g. with regard to import and manufacture of cars, populist measure of giving free power to farmers, and ignoring large deficits incurred by state electricity boards. Population explosion, rising expectations, and normal requirement of growth at a reasonable annual economic growth rate of 6 to 8 per cent mainly through new industrialization, mechanization of agriculture and infrastructure for export of knowledge based services put additional and legitimate demands on an already strained energy sector. An overview of energy sector (TIFAC 2000) and future directions has been postulated.

To quote some figures, there is an energy deficit of 8% and a power deficit of 16% in electrical energy supply. In the business-as-usual scenario 10 000 MW capacity is required to be added every year at a cost of one million dollar per megawatt. We have transmission and distribution losses of 20% to 22% and average plant load factor around 58% only. On the other hand, as shown in Figure 1 indigenous petroleum resources have peaked off and

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* Abridged version of the Silver Jubilee address delivered at the National Renewable Energy Convention, 27–29 December 2001, organized by the Solar Energy Society of India at Hyderabad.

Disclaimer The views expressed by the authors are not necessarily those of the organizations to which they belong nor should the articles be viewed as representing the policy of either the Ministry of Environment and Forests or TERI.

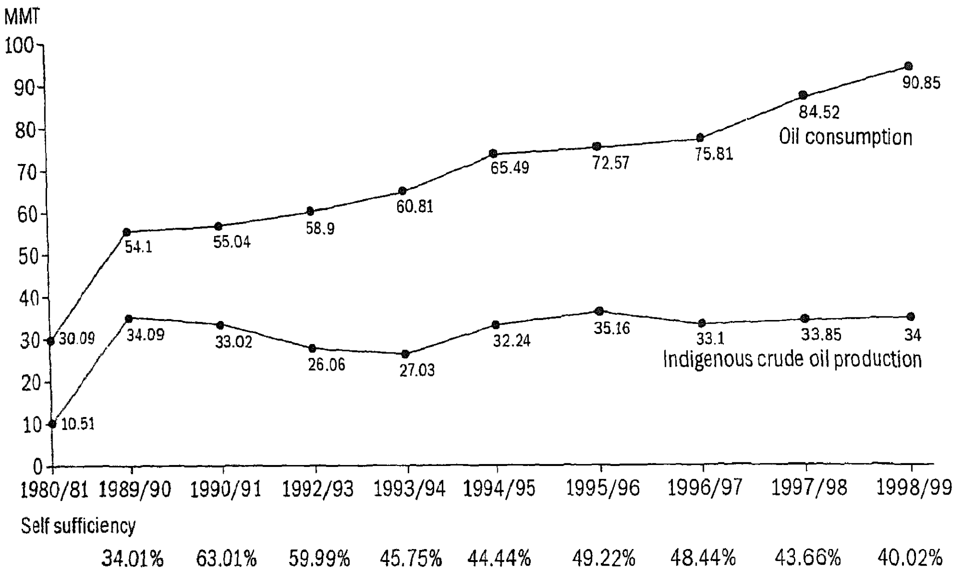


Figure 1 Oil consumption versus production
Source The Bulletin on Energy Efficiency 2(1), pp.9, 2001

ratio of indigenous to total requirement has levelled off. Annual energy requirements are going up as shown in Figure 2 (Kacker *et al.* 2001) and the percentage of commercial to non-commercial fuel sources is steadily increasing (TERI 2001) practically because of rural migration to urban areas and industrialization. Expected increase in agricultural energy has not

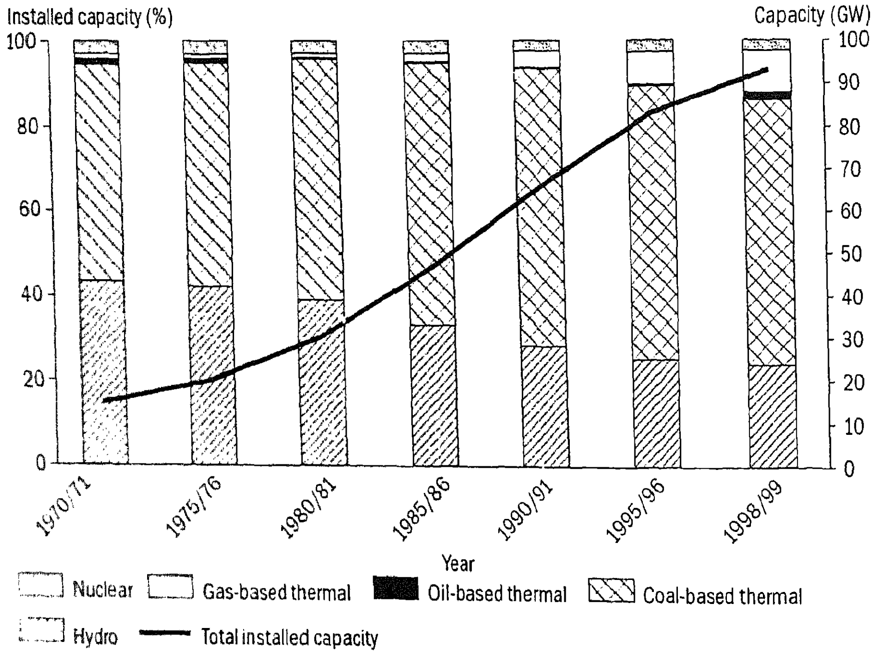
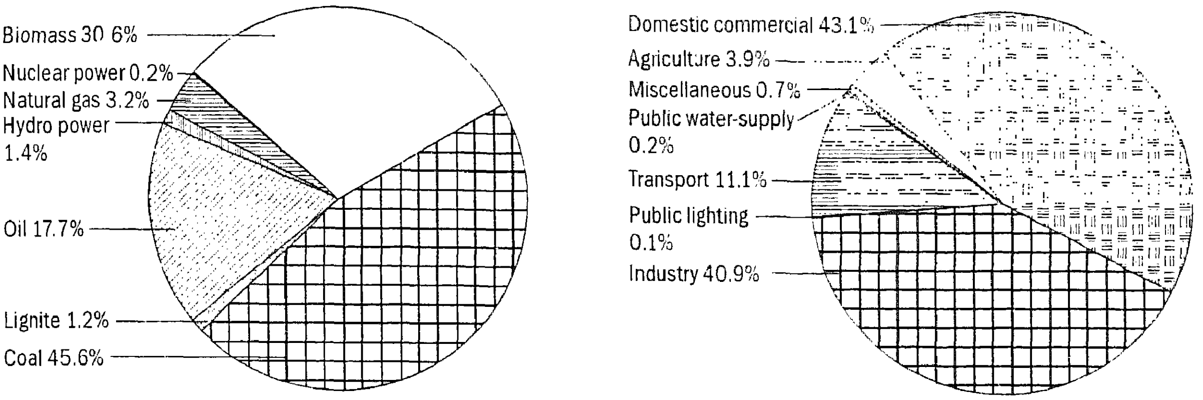


Figure 2 Total installed capacity and fuel mix
Source *Pacific and Asian Journal of Energy* 11(1), pp. 53, 2001



India's sources of energy 1995/96 (100% = 175 08 × 10^{15}J)

India's sources of energy 1995/96 (100% = 115 14 × 10^{15}J)

Figure 3 India's reference energy base (1996)
Sources IEI and CMIE

come about because farm mechanization has levelled off at least for the present. The focus of energy supply from all sources has three directions.

1 Quality power for urban areas and industries requiring international quality systems at the maximum efficiency to beat space constraints and ensure energy security.
2 Rural energy supplies based on maximizing efficiency/unit capital cost and possibly maximum output/life cycle cost and creation of sustainable livelihoods at affordable investments.
3 Niche areas like remote installations on islands, mountains, high security essential services, and corporate uses in hotels/hospitals etc., and use of Basic Needs Programme for the very poor.

Also from the initial objectives of meeting the basic needs and achieving self-reliance based on *Swadeshi* model there is a stress on income generation and servicing of knowledge-based outputs in global competition under safeguarded International Property Rights. Only time will tell whether this is in the right direction or not, but it is the ground reality partly because of globalization and partly because of consumerism. Figure 3 gives a reference base (1996) for India's energy sources and sectors of use (IEI and CMIE).

What has been done

Policy determinants

India's energy problem is so very multidimensional in terms of needs of a highly stratified society and development tasks of rural and heavy industrialization, knowledge-based service industries and increasingly productive agriculture implying factors of energy security, quality, food security, and sustainability that one can hardly decide where to begin. In addition, there are considerations of ecological stability requiring clean development without adverse climatic impacts. This requires a proper cultural context for development and perceptive heart-sets (rather than ineffective mindsets) so that appropriate strategies and systems can be formulated in an open manner. From this basic presumption, the following principles of sustainability follow almost axiomatically (Gupta 2001).

1 Analysis of projected loads and fuels or ambient resources available should be used on the demand side. System configuration should satisfy the sustainability index defined by the least annualized cost per unit of livelihood created on a long-term basis (Gupta 2001).
2 Hybrid energy systems are usually called for as opposed to single systems. Constituent subsystems should be chosen on the basis of minimum cost per unit efficiency rather than minimum cost or maximum efficiency. This allows for hands-on innovation at the local level, which is crucial for involvement and economic empowerment as well as for the running of systems with least down time.
3 To have credibility, efficiency and cost must be secondary in pilot trials when compared to effective work making the best of available environmental conditions. Countless technologies have failed because of confusion between effectiveness and efficiency.

National programmes

During the last 25 years, many national programmes based on R&D outputs relative to societal needs have been initiated e.g. biogas, cook-stoves, home lighting, gasifier-based village electrification, solar cookers, solar pumps for agriculture, etc.

Goals and achievements

The goals and achievements of our national programmes in renewables so far are given in Table 1 (Khullar 2001).

Table 1 Goals and achievements of national programmes

Source/Technology (estimated)	*Potential* (till 31 August 2001)	*Achievements*
Biogas plants (numbers)	12×10^6	3.22×10^6
Improved cook-stoves (numbers)	120×10^6	33.86×10^6
Biomass power	19 500 MW	343 MW
Biomass gasifiers	–	41 MW
Solar photovoltaic power	20 MW/km^2	
Street lights		41 403 numbers
Power plants		1132 kW
Pumps		4204 units
Solar heat (collector area)	30×10^6 m^2	0.59×10^6 m^2
Cooking		0.51×10^6 units
Wind power	45 000 MW	1367 MW
Small hydro	15 000 MW	1398 MW
Hybrid systems	–	101 kW
Energy from wastes	1700 MW	1602 MW
Battery operated vehicles	–	240 numbers

Source Achievements in Renewable Energy Programme in India. *Aditya* 9(2): 2 (2001)

Development of renewable energy technology options (1976–2001)

Defining matured technologies as those, which have gone through qualifying tests and pilot-scale testing in the field so as to be bankable projects, the following renewable energy technology options can be considered matured for India, as a result of efforts during the last 25 years (Gupta 2000).

Solar thermal

- Solar water heating from 100 LPD (litres per day) to 100 000 LPD
- Roof integrated solar air heating systems up to 400 m^2 for plantation crops, spices, and pulses
- Solar passive systems for space heating in cold climates
- Solar cookers for domestic and community cooking up to 10 000 persons
- Solar distillation for laboratories, railways, petrol stations, primary health centres, and lighthouses.

Solar PV

- Roof top lighting systems for homes and schools (up to 5 kW)
- Pumping systems for water supply for agriculture and community use from wells up to 100 metres deep
- Solar power systems up to 100 kW peak with grid interphasing or stand-alone with battery backup.

Passive and low energy architecture

- Roof top fabric cooling systems for multi-storeyed buildings such as offices, hotels, and hospitals
- Passive draft evaporative cooling systems for commercial buildings and laboratories
- Roof pond with moveable shades for houses for hot dry and hot humid climates
- Low energy building materials with embodied energy per unit floor area at one-third of the existing buildings without reduction of life or comfort.

Wind power

- Multi-bladed wind pumps with rotor diameters up to 7.5 metres and well depths up to 100 metres
- Wind chargers up to 4 kW
- Wind generators based on overseas technology with considerable indigenization up to 0.5 MW for a single machine with a farm configuration up to 10 MW
- Wind generators up to 200 kW in a single machine of indigenous design (Bharat Heavy Electricals Ltd).

Small hydro power

- Micro hydro plants up to one megawatt with heads up to 100 metres, lowest being 3 metres and a few kilowatts.

Biomass

- Biogas plants up to 85 cubic metres per day with wastes from animals, human beings, kitchen, vegetable markets, slaughter house wastes, and mixed wastes including garbage
- Biogas plants up to 135 cubic metres per day from distillery spent wash and sugar press mud
- Biomass gasifiers up to 500 kW electrical based on wood, woody wastes, and powdery biomass including sawdust, rice husk, and coffee grinds
- Refuse derived fuel from solid municipal wastes up to 200 tonnes per day.

Micro power systems

- Thermal and power requirements for sugar-cum-distillery complexes
- Complete power requirements for agro industries such as marigold flower processing, starch making etc.

Infrastructure

During the last 15 years, a full-fledged infrastructure has been installed and a manufacturing base established for most renewable energy systems including balance of system components and even device grade purity silicon for SPV cells. There are Indian standards for solar water heaters and solar cookers and near standard qualifying tests for solar cells and gasifiers.

At the government level, there are nodal agencies for each state to oversee, execute and monitor the central and state government funded projects in each state.

There are nine regional offices of the MNES (Ministry of Non-conventional Energy Sources) whose jobs have fluctuated from being redundant to being super cops. They could act as innovation relay centres for transferring latest technology to field projects and input feedback from the field to R&D agencies through MNES so that a continuous cycle of upgrading can be maintained. They can also feel the real needs of the people and input into what should be developed at R&D, innovation, and manufacturing levels. This must happen if the research-innovation-product-user-education chain has to be completed.

Non-governmental organizations and voluntary agencies

There is the famous example of the Barefoot College at Tilonia in Rajasthan, which has transformed school dropout village youths to first class innovators for commissioning and maintaining systems in far flung villages encompassing solar lights, hand pumps, biogas plants, water heaters etc. Intermediate Technology Group of Schumacher's Indian Subsidiary IT Power (India) is concentrating on design and installation of hybrid systems and CFC-free cold chains. Gram Vikas in Orissa has initiated a mass scale biogas programme in the state (Deenabandhu model was first tried here). SELCO (India) and AURORE at Auroville are upcoming grass roots energy service agencies. At the commercial level, Shell Solar and Shakti Urja are taking their first marketing steps. These are trailblazers but there are thousands of NGOs all over the country.

What has to be done

An integrated plan of action for renewable energy as a sector of National Energy Policy has yet to see the light of day. In our view the following five aspects have to move in tandem within any eco-sensible energy options.

1 Better generating efficiency through cogeneration, combined cycle, and advanced cycles of power generation. The best option here is to use the IGCC (Integrated Gasification Combined Cycle) route, which involves coal gasification and combustion of the synthesis gas in combined cycle gas turbine. In the US 80 MW power systems have been demonstrated and a 6-MW IGCC power plant has been successfully operated by BHEL in India as late as 15 years ago. A feasibility study for setting up a 100-MW plant of this genre was prepared 10 years ago and has been gathering dust since that time because of quibbling about the proper size. Much time seems to have been lost in the paralysis of multiplicity of choices about plant size, location, and implementation. It is time that we make up our mind and not let global markets nip another possibility in the bud (Ramachandran 1999).

2 Energy conservation and demand side management through higher end-use efficiency. About 25%–30% reduction in energy demand can be achieved just by good housekeeping—as many energy audit studies by various agencies have shown over a period of time. Many progressive industries already have these protocols in place. On the domestic front in

lighting alone the connected loads and energy consumption can be reduced by 80% with a simple payback period of less than three years for the additional capital investments required for using efficient luminaires and lamps. Higher set temperatures, based on adaptive comfort standards, for summer cooling in air-conditioned buildings also fall into this sector (Rajan 2001).

3 Recycling of wastes of all types with the added advantage of pollution reduction and value added products as refuse derived fuel or nutrition rich bio-fertilizers with 80% water recovery in case of liquid wastes and almost zero landfill for solid wastes.

4 Policy changes for low energy choices and reduction of energy intensity in relation to transportation, agricultural operation, building construction, town planning, and manufactured items Per capita values are currently low due to lower standards but specific values per unit product are almost twice the average for industrialized countries (Bolin 1975).

5 Renewable sources of energy such as solar, wind, biomass, and small hydro below 3 MW. More efficient use of traditional fuels also comes in this category. These options are capital intensive because of upfront costs but have practically little negative environmental impacts (Gupta 2001).

All these strategies in tandem help evolve a solar India at an energy efficiency increased by a factor of 3 to 4. This will not only be sensible but also prudent. The investments involved will be far less than in adding 10 000 MW per year capacity and using it wastefully. In any case this will be clamped down because of the considerations of sustainability dictated by resource assessments and global climate.

Projects in the pipeline

Passive and low energy architecture

All traditional buildings in India using heavy weight materials in low-rise high-density neighbourhoods were of low energy architecture. Rising land costs, increasing population, and shortage of building materials have rendered these options obsolete. However, traditional respect for environment, newer scientific developments in building materials, least mass structural design, comfort studies taking into account diurnal and seasonal rhythms for fixing set temperatures, and efficient end-use appliances can be coupled together to generate newer and more sustainable design solutions. These are not yet the mainstream design practice but steps have to be taken to retrain our practising architects not only for the sake of sanity but also for their survival in face of severe competition from overseas design practices, which will enter India in a big way as soon as the services sector is opened. For passive designs we have notable successes starting from Golconde (Pondicherry) in 1940 followed by the India International Centre (New Delhi), Sangath (Ahmedabad), buildings in Ladakh, and lately Torrents Research Centre at Ahmedabad. These cover most of the climatic zones both for heating and cooling. Here again our design professionals, who are already using CAD systems for drafting, have to be retrained for undertaking such design computation by using available computer programs with the necessary degree of confidence so as to not to hamper their creativity. Energy constants of building materials, as currently manufactured in India, along with their tentative eco-rating are already available with the Building Materials and Technology Promotion Council in New Delhi.

These climate conscious energy design concepts along with adaptive comfort standards, when applied to commercial and public buildings which are increasingly being air-conditioned, will reduce the installed plant capacities by 30% to 40% and the running costs by almost half. In addition, there are such cooling methods as roof fabric cooling, passive draft evaporative cooling, and night ventilation in hot dry areas, which can almost completely obviate the need for normal air conditioning. For climates, where both heating and cooling are required, sky therm systems and heat pump systems can be usefully employed. They have little energy costs and can pay for the extra investments in less than two to three years. Both technologies are available in India. Building energy management systems for day lighting and other services using electronic sensors are slowly being adopted in big complexes such as hospitals, office buildings and multi-use plazas. Recent examples are the CMC building in Mumbai and the India Habitat Centre in New Delhi.

Green cars

Starting with zero emission electric vehicles based on storage batteries, we can graduate slowly to hybrid cars using baseline petrol engines topped with electric drives and to fuel cells cars operating on hydrogen or directly fed methanol derived from biomass/fossil fuels. This process must start now because all the catalytic converters – diesel engine multi-fuel injection systems, unleaded petrol – are transitional technologies. Electric powered cycles, scooters, and efficient public transport can considerably obviate the need for cars. Unavailability of parking space and choking of urban roads will in any case decide the issue after inflicting lot of suffering and sickness. This choice is still possible, because we are just taking off for the motorized life style (Shukla 2000).

Microbial hydrogen using photolytic bacteria

The MCRC (Murugappa Chettiar Research Centre) at Chennai, after a decàde-long study of photolytic bacteria, have now optimized a blend of microbial co-culture of *C:freundii* and biogas isolates to produce hydrogen sustainably from spent distillery wash, sago waste, and whey in the laboratory. A pre-commercial pilot-scale plant of 6m^3 bioreactor capacity (nominally 10m^3 for dilution to suppress sulphate inhibitor) using distillery waste as substrate has been commissioned and tested at a factory site by the MCRC. It produced 1.2 m^3 of hydrogen per hour at a purity level of 96%. In most photo biological systems using natural activity of bacteria and green algae to produce hydrogen, conversion efficiency from Sun to hydrogen is nearly five per cent; the process being absorption of sunlight by chlorophyll and enzymatic use of this energy to dissociate water to produce hydrogen and oxygen. The oxygen implies that for production to be on a sustainable basis the inhibiting oxygen is removed microbially and the efficiency of Sun to hydrogen is increased considerably. In pre-commercial pilot plant hydrogen was used in an exploratory trial to operate a PEMFC (proton exchange membrance fuel cell) of 250-watt capacity developed by the SPIC Science Foundation in Chennai. Based on the parameters of a pilot plant capacity of 6 m^3, a 70 m^3 bioreactor plant has been designed and is under fabrication at Parry & Company at Nellikuppam in Chennai (M Vatsala 2001 – private communication).

Storage of hydrogen

Hydrogen is being projected as the clean renewable fuel of the future. Its energy conversion efficiency is higher than the hydrocarbon fuels and the clean combustion leads to zero pollution and better engine life. The safety aspects are not more severe than those of other fuels. However, because of low density of hydrogen, its energy density per unit volume is low and, therefore, compact containment of storage as well as its delivery are of critical importance to its use. Mr Srinivasmurthy has outlined these details (private communication). Metal hydrides have high energy density of storage, flexible PTC (pressure-temperature-concentration) curves characteristic making them easier for delivery and creating no hazard in terms of time of storage or even leakage. However, there are problems of cost, lower thermal conductivity, particle breakdown and swelling, and pyrophoricity. These are proposed to be solved by simple chemical and physical methods. Also, inexpensive hydriding alloys are being synthesized and characterized so as to yield cost effective systems for hydrogen storage and delivery. The hydrogen thus available has experimentally been used for running motorcycles at the Banaras Hindu University in Varanasi, at the National Physical Laboratory in New Delhi for a refrigerator prototype, and at the Indian Institute of Technology in Chennai for designing efficient heat transfer reactors suitable for heat pumps and fuel cells (MNES New Technologies Sector report for Tenth Plan).

Fuel cells

Fuel cell is a highly efficient and clean electrochemical device for power generation. In combination with the use of waste heat, the overall energy efficiencies of about 75%–80% can be achieved. Because of modular nature, fuel cells are suited for onsite as well as decentralized power generation. Several institutions and industries are working in the area of fuel cells in the country. Basic research and institutional basis have been created, which help in developing the fuel-cells technology for decentralized power generation, transport, and other applications. Efforts are on to improve the performance, reliability, and durability of fuel cells and bring down costs for wider application of fuel-cells technology.

The MNES has taken up projects on different types of fuel cells through R&D institutions, CSIR (Council of Scientific and Industrial Research) laboratories, universities, industries, etc. The projects aim to develop low cost materials, catalysts and components, and to strengthen the manufacturing base for the production of fuel cells in the country. Small phosphoric acid fuel cells and proton exchange membrane fuel cells have been developed. As part of an R&D project, supported by the MNES, the BHEL in Hyderabad has developed a 50-kW phosphoric acid fuel cell power plant using two stacks of 25 kW each. The technology for processing of bipolar plates and electrodes had been developed by BHEL, under this project.

The PEMFCs operate at relatively low temperatures (below 100 °C). The electrolyte is a solid polymer and there is no problem of corrosion. These features make PEMFCs attractive as a potential power source for electric utilities, portable and transport applications. As part of an R&D project funded by the MNES, a 25-kW stack was assembled and operated by the SPIC Science Foundation. Efforts are continuing to develop suitable and durable ion-exchange membranes for use in PEMFCs and to further improve cell characteristics and carry out studies on long-term performance of cells and systems to establish reliability and service life.

The MCFCs (molten carbonate fuel cells) can use methane and coal gas as fuel. The operating temperature is about 650 °C. At the high operating temperatures, MCFCs produce waste heat, which can be utilized for cogeneration and other applications. This type of cell is fuel-efficient. The MCFC power plant can be operated on different fuel cells for power generation. The Central Electrochemical Research Institute in Karaikudi has developed expertise for the preparation of $LiAl O_2$ ceramic powder for making matrix material.

The SOFCs (solid oxide fuel cells) operate at temperatures of about 850 °–1000 °C. They offer recoverability of waste heat, high conversion efficiencies and high power density. Since SOFCs consist of solid components their service life is expected to be more than the other types of fuel cells. An R&D project funded by the MNES was also sponsored at the Indian Institute of Science in Bangalore for the development of suitable materials and basic cell fabrication technology. Conductivity and thermal expansion properties of these SOFC materials were studied. Under an R&D project funded by the MNES, the Indian Institute of Science in Bangalore and the Indian Institute of Technology in Chennai are developing 100-watts and 250-watts solid polymer electrolyte—direct methanol fuel cells.

Electrochromic windows

The switching operations of an ECW (electrochromic window) demand a small DC voltage. In a typical ECW the current densities involved are of the order of 0.1 mA/cm^2 and the switching times are in minutes. The power required to operate an ECW is generally drawn from the mains via special wiring. This adds to the installation cost of an ECW, in addition to the operational cost, however small it may be. One of the ways for lowering the installation charges and to make an ECW self powered is the integration of EC (electrochromic) and PV (photovoltaic).

A small area PV cell can provide sufficient electrical power to switch a large area ECW slowly, as would be appropriate for an architectural window. Table 2 lists some typical characteristics

Table 2 Photovoltaic and electrochromic compatibilities

General characteristics	*PV*	*EC*
	(aSi:H 5% efficient)	(Li^+ ion based)
Voltage (V)	0.85	0.80
Current density (mA/cm^2)	35^+	10
PV requirements for switching one sq. metre EC^+	PV area x conversion efficiency (m^2)	switching time (S)
	0.005	80
	0.05	8

+ Assume 600 W/m^2 irradiance

of EC coatings and thin film, hydrogenated amorphous silicon (aSi:H)PV cells and shows general compatibility. Typical PV current density output is generally compatible with the switching requirements of an EC device, as are the overall energy and power densities.

Different designs integrating EC with PV e.g., side-by-side PV-EC or the tandem PV-EC can be employed. In the former design, the PV array can be interconnected to provide multiples of the individual cell voltages whereas in the latter one, the single cell PV voltage can be increased by incorporating a dual-injection cell at some cost in window transparency.

Based on this novel concept, devices employing a wide band gap thin film a SIC:H n-I-p- as a PV solar cell and a $LixW0_3$ / $LiAlF_4$ /V_20_5 deposited monolithically on a conducting glass substrate have been successfully demonstrated. The thin film group at the National Physical Laboratory has initiated this study recently to find a suitable combination of EC and PV for architectural windows (private communication).

Role of MNES/IREDA/NIRE

The MNES is the focal ministry funding and overseeing the institutional R&D efforts, pilot demonstration programmes, and laying down qualifying tests for technology approved for mass scale application with decreasing subsidies but other financial benefits engineered to reduce payment periods to less than five years. IREDA (Indian Renewable Energy Development Agency) is the financial arm for soft loan funding and NIRE (Sardar Swaran Singh National Institute of Renewable Energy) is being groomed as the coordinating technical arm for developing biomass, hybrid systems, end-use packages and integrating research in solar, wind, small hydro and through other already existing MNES centres.

Measures for streamlining R&D programmes in selected thrust areas of national relevance

The R&D work funded by the MNES has directly or indirectly led to evolution, development, and maturing of at least 20 renewable energy technologies to a pre-commercial level during the last 15 years. On the one hand it is the time now to lead these from pre-commercial to marketable stage, thereby making an impact at the national level and for the common man. On the other hand R&D has to replenish and review research and design efforts for a second set (Mark II) of technologies for the immediate future. It is sobering to realize that there is not a single resident Indian author in the latest publication of the ISES (International Solar Energy Society) titled *Status of Solar Energy* (Gordon 2001). Some of the measures needed are given below.

- Delineating new thrust areas with a finer resolution, than hitherto so as to yield specifications for RFPs (request for proposal bids) for 80% of mainstream funding leaving 20% for individual creative initiatives that arise on their own. The RFP sector should have clearly defined goals in terms of technological, economic and social objectives, milestones, and outputs.
- Funding should be done on the basis of rigorous screening. Projects should be assiduously monitored and continued or aborted on the basis of mid-term reviews. All projects with a gestation period of three years or less with a funding of more than 2.5 million should be reviewed biannually and those with a funding of 1.0–2.5 million should be reviewed annually.

- Concurrently, efforts of at least two Plans (Eighth and Ninth Plans) should be reviewed with a subject-wise analysis and an institution mode analysis to lead to the following.
  - Identification of neglected areas or any imbalances in distribution of resources.
  - Designation of priority areas.
  - Rating of institutions in terms of their record of achievements for future funding.
  - To produce a consolidated monograph of success stories for each of the technologies now available.
  - A restricted report of success/failure analysis of R&D components of various national programmes of biogas, firewood efficient cook-stoves, small hydro, SPV, wind, energy from municipal and industrial wastes, solar passive architecture so as to focus on the areas required for strengthening or cancelling. This is very important in view of availability of emerging technologies from global sources flowing into India.
  - A new division on energy and habitat should be set up at the MNES as it consumes 25% of total national energy and has maximum scope of incorporating Factor 4 efficiency technologies at design, construction, industrial, and operating levels i.e. technologies primary energy input per unit product by a factor of four.

Monitoring and accountability

This is generally a weak part of all Indian efforts including R&D of MNES. This culture should be built up with diagnostic norms so as to contribute to learning exercises and building up of confidence. Evaluative norms are also required for financial and administrative reasons but they are shunned and can be counter productive in the prevailing culture of diffusion of responsibilities and passing the buck practised throughout the country at almost all levels.

Signature areas

At a national level, areas for spearheading are green architecture and biomass-based power plants up to one megawatt (Mukunda 1999), which could be extended later to fuel cell power plants and micro turbines.

Concluding remarks

India is a sunny country having a bright future. However, to realize, we have to imbibe some of the qualities of sunshine—vastness, warmth, and luminosity.

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Techno newsbriefs

From newspapers, magazines, and trade journals

Tree-oil substitute for diesel

Energy Times 24(35): 7 (2002)

Deriving oil from wild trees as substitute for diesel could completely replace the current use of fossil fuel and help India overcome the huge six billion dollar oil import bill, said U Srinivasa, Chief Programme Executive of the Sustainable Transformation of Rural Areas Projects, at the Bio 2002 Conference held in Bangalore. According to him, oil-bearing trees like *Pongamia Pinnata* are ideal for this purpose. Every 10 million hectares of tree cover could yield 25 MT (million tonnes) of diesel substitute and another 70 MT of cake. When fermented, the cake could be used to substitute equal quantity of coal.

Hydrogen produced from distillery wastes

Indian Chemical Engineer 44(1): 62 (2002)

The Murugappa Chettiar Research Centre of Chennai has developed the process for sustainable production of hydrogen from spent distillery wash, sago waste, and whey, in the laboratory. A pre-commercial pilot scale plant using distillery waste as substrate has been commissioned and tested at a factory site. The hydrogen so produced has been used in an exploratory trial to operate a fuel cell. Now a higher capacity bioreactor plant, based on the parameters of the pilot plant has been designed. Even as hydrogen is being projected as a clean renewable fuel of the future, with hydrogen's energy density per unit volume being low, compact containment of storage as well as delivery are of critical importance to its use.

Super-efficient hydrogen generator

Refocus March-April: 10 (2002)

Kobe-based Shinko Pantec Company has developed a highly efficient type of hydrogen generator for the production of hydrogen gas for fuel cells. The system produces hydrogen through electrolysis of water with an energy efficiency of 90%, far exceeding the 60% energy efficiency of the company's existing line of equipment. As a result the new system consumes just 4 kWh of electricity to produce one cubic metre of hydrogen. The new hydrogen generator is built from a stack of 25–50 electrolysis units, each made from an electrolytic membrane sandwiched between electrodes. The electrodes of the new system has been shaped as smooth sheets, the reaction temperature has been raised from 50 °C to 80 °C and the resistance of electrodes reduced.

European Union to electrify 500 South African village schools

Photovoltaic News 21(3): 6 (2002)

The EU (European Union) launched a solar electrification scheme that will eventually benefit about 500 village schools in

Tsolo district, according to Eskom spokesperson Lettitia Ndema. The EU has provided R96 million for solar electrification and the purchase of related equipments aimed at rural schools in the Eastern Cape and Northern Province. Energy and Mineral Affairs Minister Phumzile Mlambo-Ngcuka, Education MEC Stone Sizani, EU delegates and Eskom officials witnessed the installation of audio-visual equipment and non-grid electrification in Tsolo. Non-grid electrification is being provided in areas outside Eskom's five-year plan for electricity provision.

Fuel cell–gas turbine hybrid power plant generates electricity

Energy Times 24(32): 8 (2002)

The Siemens Westinghouse Power Corporation and the Southern California Edison have jointly developed the world's first fuel cell–gas turbine hybrid power plant which generates electricity. The system combines a Siemens Westinghouse solid oxide fuel cell with an Ingersoll-Rand micro turbine. In the California unit, the two technologies combine to produce approximately 190 kW of electricity, enough to power 200 homes. This combination is pushing power efficiencies to unprecedented levels. Early test data show electrical efficiencies of approximately 53%, believed to be a world record for the operation of any fuel cell system on natural gas. Improvements in the technology could ultimately raise efficiencies to 60% for smaller systems and 70% or higher for larger systems.

Hybrid solar cell fabricated

Chemical and Engineering News April: 15 (2002)

A new solar cell, which uses a semiconducting film of cadmium selenide nanorods dispersed in an organic polymer, has been fabricated. The hybrid cells could find use in intermediate applications that require more solar power conversion efficiency than conventional solar panels but less than the highly efficient, expensive cells made for satellites, according to the group at the Ernest Orlando Lawrence Berkeley National Laboratory of the University of California that developed the device. The group showed that the power conversion efficiency of the devices using monochromatic light is 6.9%, one of the highest reported for plastic photovoltaic devices. Using the full solar spectrum, however, the conversion efficiency of the new hybrid cell is only 1.7%, while organic solar cells made up of polymers that can be processed from solution have reported efficiencies up to 2.5%.

India signs Russian nuclear agreement

Asian Power 10(2): 2 (2002)

Nuclear Power Corporation of India Ltd has signed a 500 million dollar contract with Russia's Atmostroyexport for the supply of two advanced nuclear reactors and other power generation equipment, in a major step towards the implementation of the Kudankulam nuclear power project. Construction of the 2 GW Kudankulam plant with VVER-1000 type reactor facilities located in Tamil Nadu has already started and when completed will contribute significantly to the power supply of the southern regions of India. The contract represents a significant step in further strengthening the cooperation between India and Russia in the field of nuclear power generation.

Draft power regulations

The Hindu 6 April 2002

The DERC (Delhi Electricity Regulatory Commission) came out with a draft regulation for grant of consent for CPPs (captive power plants) in the capital. Under the proposed draft regulations – now open for public discussion – CPPs up to 10 kVA can be set up without any consent and such power generating units would not be allowed to connect with the grid. The DERC Chairman said that for CPPs with capacity above 10 kVA, the Commission would give consent only after receiving a no objection certificate from the Delhi Government's power department. The department would look into various aspects like feasibility, pollution, and court directives in this regard. The consent of the Commission would be valid for a period of 10 years.

Standing committee on energy recommends task force on power reforms

Electrical India 42(9): 33 (2002)

To gear up the power sector reforms, the standing committee on energy has recommended creation of a high level national task force by accommodating the officials from the Planning Commission, the ministries of power and finance, state chief secretaries, and relevant regulators for overseeing power reforms. The Centre has to ensure that the states commit themselves to a time bound plan for power reforms, specifically to reduce transmission and distribution losses to 15%–20% over the next three to five years and reduction in cash losses by one-third every year. The report suggested that the power ministry should conduct technical audits of the generation, transmission, and distribution functions within each state electricity board. Financial and operational performance standards and targets should be set and the Centre should link release of its funds to the target achievements by the states.

Use of carbon dioxide in the commercial production of crude oil

Drilling and Exploration World 10(12): 8 (2001)

Japan Oil Development Co., has established a technology to effectively extract crude oil from oil reserves using carbon dioxide. Carbon dioxide recovered from thermal power plants will be pressurized and infused into oil deposits. Crude oil deposited in the reservoirs will then be pushed out. The technology, developed jointly with Mitsubishi Heavy Industries Ltd and the semi-governmental Japan National Oil Corporation will improve the rate of oil recovery from the reservoirs by around 50%.

Statoil develops new gas lift method

Drilling and Exploration World 10(12): 9 (2001)

On the Norne field in the Norwegian Sea, Statoil has adopted a new method of gas lift for subsea wells tied back to seabed templates. Free gas from the upper part of the reservoir is mixed with the oil in the well. The oil thereby weighs less and is easier to produce. The oil on the Norne field is produced from a production ship that is tied back to templates on the seabed. A valve controlling the desired amount of gas, is hydraulically operated from the ship. Sea depth is 1247 feet, and flexible risers convey the well flow to the ship.

Petroleum Regulatory Bill has arm's length clause

The Hindu Business Line 7 May 2002

A Bill seeking to set up a Petroleum Regulatory Board to oversee and regulate the refining, processing, storage, transportation, distribution, marketing, and sale of petroleum products was introduced in the Parliament (Lok Sabha). The Bill introduced by the Union Minister of Petroleum and Natural Gas, Mr Ram Naik, made it clear that the proposed Board would operate at an arm's length from the central government. It is proposed to give power to the central government to broadly lay down policy framework, besides making provisions for the central government, to intervene in matters adversely affecting pubic interest in certain exigencies. The Bill also proposes to maintain a databank on activities relating to petroleum and petroleum products, to enable planning and development.

Global LPG demand set to grow

Drilling and Exploration World 10(12): 8(2001)

Global demand for automotive LPG (liquefied petroleum gas) is set to grow by 5.9% per annum to 2009, according to Datamonitor's latest report entitled The Global Automotive LPG market 2001. Europe and Asia-Pacific are expected to show the highest growth rates with demand rising by 7% and 7.8% per annum respectively. Latin American growth will not be far behind, reports the analyst, with a predicted growth rate of 5.7% per annum. North America is predicted to be the only region to buck this trend, with automotive LPG sales expected to contract by just under 1% per annum for the next decade. This is due to the lack of government fiscal support, which is relied upon to provide consumers with sufficient incentives to switch to LPG for more polluting fuels, the report states.

Coal sector posts six per cent growth

The Tribune, 23 June 2002

The non-payment of coal sale dues by power utilities notwithstanding, the coal sector in the country has registered a 6% growth during 2001/02 with CIL (Coal India Ltd) achieving a major turnaround during the year. The coal sector carries a weight of 3.22% in the IIP (index of industrial production) and grew by 6.3% as against 2.1% in the previous year. CIL has registered a profit of Rs 14 000 million as against a loss of Rs 14 140 million clocked in 2000/01.

Abstracts of current research

- Abstracts grouped under 20 headings
- Every abstract verified against the original source
- Photocopies of original documents available
- All published abstracts (5132 records so far) available for search
- List of source documents consulted for this issue appears below

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Subject

Coal and coal products
Petroleum
Natural gas*
Oil shales and tar sands
Hydrogen
Other synthetic and natural fuels
Biomass
Wood energy
Hydro energy
Solar energy
Geothermal energy*
Tidal and wave power*
Wind energy
Electric power engineering
Energy storage*
Energy planning and policy
Direct energy conversion
Energy conservation, consumption, and utilization
Advanced automotive propulsion systems
Engineering*

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* No abstracts on the topic appear in this issue

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Regional Wood Energy Development programme in Asia: pp. 42–47, FAO, Regional Office for Asia and Pacific, Bangkok, Thailand. [RWEDP Report No 61]

Coal and coal products

Prediction of clean coal yield and ash at coal washeries using a combination of neural network and empirical models

[230] The prediction of clean coal yield from coal washeries has always been of utmost importance to washery personnel. The prediction, through models, is cumbersome; it involves conducting a large number of sink-float tests and drawing of graphs to determine the efficiency of separation units. Though the principles of DM (dense medium) cyclone separation and froth flotation are well known, not much is known about the actual separation process taking place inside these cyclones or during froth flotation. The processes are more of a 'black box'. For such situations ANN (artificial neural network) has been found to be the most suitable tool, which can give reliable prediction from available data. ANN is an artificial intelligence tool that can be used for determining co-relations in a multi-variable non-linear system for extracting information from raw data. The paper describes in detail, the use of ANN for predicting the performance of forth flotation circuit, and the use of empirical model and ANN for predicting the performance of DM cyclones. (5 figures)

Sripriya R and Soni. 2002
Journal of the Institution of Engineers (India)-Mining Engineering 82 (February): 52-56

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Potential of fly ash utilization in India

[231] A simple framework for estimation of fly ash utilization potential in India has been developed in this paper. Fly ash utilization in cement production, construction of road embankments, and manufacture of bricks has been considered. The results obtained for the projected levels of fly ash utilization clearly show that in spite of assuming quite optimistic levels of fly ash use in the three applications, the overall fly ash utilization is less than 25% of the total fly ash produced. Therefore, either a much more aggressive fly ash utilization strategy has to be developed and executed, or the extent of the fly ash utilization target (or the year of achieving a specified target) should be reviewed by the Ministry of Environment and Forests. (2 figures, 5 tables, 29 references)

Bhattacharjee U and Kandpal T C. 2002
Energy: The International Journal 27(2): 151-166

Centre for Energy Studies, Indian Institute of Technology Delhi, Hauz Khas,
New Delhi - 110 016, India
<tarak@ces.iitd.ernet.in>

Rheological behaviour of coal-water slurry

[232] The use of highly concentrated CWS (coal-water slurry) as a fuel is gaining worldwide importance. The rheological behaviour of some Indian CWS was investigated in this paper using a HAAKE RV30 viscometer. The objective was to study the effect of solid concentration, ash content, pH, and temperature on the rheology of CWS. It was found that CWS exhibits pseudoplastic behaviour. The apparent viscosity varies with the amount of coal in the slurry, pH, and temperature. It is highest around pH 6 and the lowest near pH 8. The effect of temperature on the viscosity could be described using an Arrhenius type of relation. (6 figures, 2 tables, 20 references)

Mishra S K, Senapati P K, and Panda D. 2002
Energy Sources 24(2): 159-167

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Optimization of longwall panel design in overcoming the strata control problems at JK-5 Incline, SCCL—a case study

[233] The JK-5 (Jawahar Khani - 5) Incline - longwall - has been in operation since 1990. During the last 12 years, eight longwall panels were completed giving a total output of 2.4 MT (million tonnes). Out of eight panels, four panels were completed with 135 metres face length in the top section leaving 6 to 9 metres

shaly coal in the roof in a 20-metre thick seam. Two panels i.e., 1-B and 2-B were successfully completed for the first time in India under the goaved out top section longwall panels with a minimum partition of 3 metres, and two panels with 90 metres face length in the top section. The success of any longwall system depends mainly on the effect of the overlying strata (8 to 9 times of the mining height), the resistance offered to the strata by the supports, and the longwall panel design. The CMRI (Central Mining Research Institute) has recommended 400 tonnes capacity powered supports with 1.5 metres spacing after studying the physico-mechanical properties of the roof rock and the longwall panel design. Accordingly, 4 × 450 tonnes IFS (immediate forward supporters) were procured for 135 metres face length at the JK-5 Incline. After working on few panels in the top section with 135 metres face length, the 4 × 450 tonnes IFS were found to be underrated. The overlying strata effect for the same working section will be the same with the same panel design. Hence, a decision was taken to reduce the face length from 135 metres to 90 metres in the top section in order to overcome the strata control problems and to extract the remaining reserves successfully. The panels numbered 5 and 3A with 90 metres face length were successfully completed and presently panel number 3A is under salvage. The main theme of this paper is to present the experience gained with strata control problems in panel numbers 5 and 3A with 90 metres face length. (3 figures, 2 tables, 4 references)

Purushotham A and Reddy B V. 2002
The Indian Mining and Engineering Journal
41(3): 34-40

Yellanadu Area, The Singareni Collieries
Company Ltd, Andhra Pradesh, India

Illumination survey and cost analysis for a large-scale opencast coal mine

[234] Illumination is undoubtedly a vital aspect in mining operations. A properly designed and implemented lighting system would provide the mine workers with improved visibility, and contribute to improved safety, productivity and high morale. In this paper a detailed illumination survey has been carried out for a large-scale opencast coal mine producing 600 000 tonnes of coal per annum. Survey data revealed that the illumination levels at major parts of the mine are below the recommended standards. Detailed calculation showed that the illumination cost is an insignificant component of overall production cost. For the mine under study, cost of illumination is Re 0.74 per tonne of coal, which constitutes only 0.27% of the coal production cost. A little increase in the illumination cost would bring the light level of the mine up to the desired standards. (2 tables)

Karmaker N C and Chauhan B S. 2002
The Indian Mining and Engineering Journal
41(4): 29-30

Department of Mining Engineering, Indian
School of Mines, Dhanbad - 826 004,
Jharkhand, India

Efficacy analysis of treatment plants for workshop and mine effluents in Mahanadi Coalfields Ltd

[235] Responding to the Environment Action Plan under the World Bank, ESMP (Environment and Social Mitigation Project), treatment plants for the workshop effluents and the mine effluents were constructed in all the six World Bank-assisted opencast mines of Mahanadi Coalfields Ltd, Orissa. The present study describes the quality and the quantity of the effluents entering these treatment plants, technical details, comparison with respect to the conventional/standard systems, cost of construction, operation and maintenance, manpower etc. Samples were collected from the inlet and outlet of these treatment plants and

were analysed at the Indian School of Mines laboratory, to generate the primary data. Efficacy analysis has also been done on the basis of secondary and primary data, and effluent quality has been compared with the prescribed standards. The proper dose of alum has also been worked out for the workshop effluent treatment plants. It was observed that all the treatment plants are working satisfactorily with respect to the removal of total suspended solids, oil and grease, etc. and the effluents conform to the relevant standards. Due to improper dosage of alum, the pH was deviating from the prescribed standards and hence it must be ensured that proper dosage of alum, i.e., 75–80 mg/l, as worked out, is used to avoid this problem. Proper training regarding the importance and significance of these treatment systems is also required. (5 figures, 9 tables, 7 references)

Singh G and Jha S. 2002
The Indian Mining and Engineering Journal
41(4): 21-28

Centre for Mining Environment, Indian School of Mines, Dhanbad - 826 004, Jharkhand, India

Petroleum

[236] **Heavy crude oil viscosity reduction for pipeline transportation**

The low mobility and high viscosity of heavy crude oil sometimes makes it unfit for pipeline transportation. The approaches used for reducing the viscosity of heavy crude include heating, blending with light crude and with kerosene, and forming oil-in-water emulsions. Heating had a dramatic effect on heavy crude viscosity, but failed to achieve a practical level. Blending the heavy crude with either light crude or with kerosene proved to be an expensive process as substantial amounts of these expensive diluents were required. This paper presents a study carried out with oil-water emulsions to reduce the heavy crude viscosity. It was established that a practical level of reduction is achievable at 70%–75% oil content, in high shear rate range and 30–35 °C. The study concludes that the reduction of the viscosity of heavy crude by the formation of emulsions that contain between 25% and 30% water is now a likely approach since water is cheaper than either light crude or kerosene, and the surfactant used to stabilize the emulsion need not be broken down at the final destination if the oil is to be used to fuel power plants.
(7 figures, 7 references)

Yaghi B M and Al-Bemani A. 2002
Energy Sources **24**(2): 93-102

PMRE Department, College of Engineering, Sultan Qaboos University, PO Box 33, Khoud 123, Oman

[237] **Petroleum products depot automation system from BHEL**

Oil companies in India and abroad operate depots or terminals for bulk distribution of petroleum products. These depots receive the products from the refinery, stock them in storage tanks and load into tank trucks that take the products to retail outlets. There are hundreds of such depots throughout India that need to be computerized. BHEL (Bharat Heavy Electricals Ltd) had developed such a computerized automation system called the PDAS (products depot automation system) and had offered it to oil companies, as an original equipment manufacturer. One such system is operating at Sanathnagar depot of the Indian Oil Corporation Ltd in Hyderabad. This paper brings out the functions and various components of the petroleum PDAS of BHEL. Some of the benefits of an integrated depot automation system are (1) accurate product filling, (2) efficient inventory management, and (3) time reduction in loading operations through better scheduling. (1 figure)

Lakshminarayan T. 2002
BHEL Journal 23(1): 1-7

Editor, BHEL Journal, Bharat Heavy Electricals Ltd, BHEL House, Siri Fort, New Delhi - 110 049, India

Artificial neural network based estimation of petroleum and product properties

[238] Computation through neural networks is one of the recently growing areas of artificial intelligence. Neural networks are promising due to their ability to learn highly non-linear relationships. The present work deals with the estimation of various characterization parameters of crude petroleum and the prediction of some specific properties of different petroleum products. ANN models using a backpropagation algorithm for training have been used to provide the predictions of critical properties, molecular weight and a centric factor of the pseudocomponents of crude; and also for the estimation of certain properties such as Reid Vapour Pressure for straight run naphtha, flash points for kerosene and gas oils, pour points for gas oils, recovery at 366 °C for heavy gas oil and residual crude oil, and specific gravity for most of the petroleum products. These properties are required to be estimated for inferential control and on-line optimization of refinery processes. The prediction errors are well within the permissible limits for a variety of crude oils and petroleum fractions examined. (6 figures, 4 tables, 15 references)

Ganguly S, Sadhukhan J, and Saraf D N. 2002
Indian Chemical Engineer 44(1): 7-12

Department of Chemical Engineering, Indian Institute of Technology Kanpur, Kanpur - 208 016, India

Evaluation of hydrocarbon source rock potential from well data on the Elmali Nappes, Western Taurus region, Turkey

[239] Possible hydrocarbon source rocks are located in the northwest of the Western Taurus region within a Mesozoic-Cenozoic carbonate platform sequence that consists of the Elmali Nappes units and the adjacent autochthonous Beydaglari units. The hydrocarbon source rock potential of this area, belonging to a number of different sedimentary cycles and tectonic units, was studied on core-samples with a Leco WR 12 apparatus and Rock Eval pyrolysis. Two significant source rock intervals, which were penetrated by the Buyukalan-1, Altinyayla-1/A, and Kirkpinar-1 wells representing an area of about 1200 km^2, occur within and beneath the Elmali Nappes, namely, (1) the unit from the Lower-Middle Eocene to the Burdigalian Yavuz Group, and (2) the Aquitanian-Burdigalian Sinekci Formation. The thermal maturation of these units resulted mainly from tectonic burial during Middle Miocene overthrusting. The total organic carbon values of most of the samples are about 0.3%. This suggests a source threshold of organic carbon for limestones. The S_1, S_2, hydrogen index, and T_{max} values from the Rock Eval pyrolysis indicate that the dominant organic matter is Type III kerogen that has gas generative potential. The low hydrocarbon yield of the source intervals might have been the result of the dissolution of the carbonates through karstification. (6 figures, 1 table, 18 references)

Demirel I H, Gunay Y, and Yurtsever T S. 2002
Energy Sources 24(5): 461-470

Engineering Faculty, Department of Geological Engineering, Hacettepe University, 06532 Beytepe/Ankara, Turkey
<hakkid@hacettepe.edu.tr>

Oil shales and tar sands

Oil shale: pyrolysis, combustion, and environment—a review

[240] Instances where combustion techniques have been applied for oil shale characterization, kinetics, and effect on environment are reviewed in this paper. The major themes of the review were composition, geochemistry, advanced spectroscopic and pyrolysis techniques, thermal analysis conversion including static and fluid bed retorting, and environmental considerations. The

survey literature reveals that these techniques are finding increasing application in the study of oil shales and have considerable significance in terms of the determination of the changes in properties, such as composition and decomposition characteristics, concession, calorific effects, kinetics and proximate analysis, etc. (45 references)

Kok M V. 2002
Energy Sources 24(2): 135-143

Department of Petroleum Engineering, ODTU,
06531 Ankara, Turkey <kok@metu.edu.tr>

Hydrogen

Ball-milled carbon and hydrogen storage

[241]

The ball milling of graphitic carbon results in the formation of carbon in different nanoparticle forms which can be used for storing hydrogen. This paper presents an experimental study for the ball milling of graphitic carbon and its use in hydrogen storage. The ball milling was carried out in a Szegvari attritor at room temperature for varied time periods (24, 48, and 100 hours) in a hexane medium. The results show that self-coagulated carbon agglomerates were obtained in the case of the 24 and 100 hours BMC (ball-milled graphitic carbon) samples and that the BMC samples can adsorb hydrogen at 77 K, the maximum storage capacity being approximately 0.6 wt%. (7 figures, 1 table, 11 references)

Awasthi K, Kamalakaran R, Singh A K, *et al.* 2002
International Journal of Hydrogen Energy 27(3): 425-432

Department of Physics, Banaras Hindu
University, Varanasi - 221 005, India
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Near-term introduction of hydrogen engines for automotive and agricultural application

[242]

The feasibility of the introduction of hydrogen as a fuel for automotive and agricultural applications is discussed in this paper. It also discusses several experimental investigations carried out to identify optimum performance and low-emission characteristics, and the steps identified to get rid of undesirable combustion phenomena such as backfire, pre-ignition knocking, and a rapid rate of pressure rise. The paper concludes that it is possible to use hydrogen-operated spark ignition engines in existing automobiles. However, some specific steps are to be adopted for the fuelling system and safety considerations. It is also possible to introduce hydrogen fuel in agricultural applications with 66% hydrogen-energy substitution to the diesel fuel. (9 figures, 22 references)

Das L M. 2002
International Journal of Hydrogen Energy 27(5): 479-487

Centre for Energy Studies, Indian Institute of
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New Delhi - 110 016, India
<lmdas1@hotmail.com>

Studies on PV assisted PEC solar cells for hydrogen production through photoelectrolysis of water

[243]

The production of hydrogen through photoelectrolysis of water by PV (photovoltaic) assisted PEC (photoelectrochemical) solar cells has been discussed in this paper. The formation of a polycrystalline TiO_2 film by anodic oxidation of a titanium sheet has been reported for use as a suitable semiconductor. The PEC characterization of the TiO_2 films has been carried out by employing standard electrochemical techniques. The investigations being reported involve I-V and C-V measurements, besides the use of the PEC cell for hydrogen production by employing PV power as external biasing source. The results conclude that (1) a strongly adhering and stable TiO_2 film over the Ti substrate can be formed by an anodic oxidation process, and (2) a solid state PV panel can be used with advantage as an external power source to bias the PEC cell for the PEC splitting of water. (5 figures, 1 table, 32 references)

Shukla P K, Karn R K, Singh A K, *et al.* 2002
International Journal of Hydrogen Energy 27(2): 135-141

Department of Physics, Banaras Hindu
University, Varanasi - 221 005, India
<ons@banaras.ernet.in>

Technical, environmental, and exergetic aspects of hydrogen energy systems

[244] In this paper, a number of technical, environmental, and exergetic aspects of hydrogen and hydrogen energy systems (particularly fuel cells) and their applications are discussed from an energy point of view. In addition, the exergy concept is introduced for hydrogen energy systems and exergetic aspects are discussed through illustrative examples, which show a potential usefulness of exergy in hydrogen energy systems. (12 figures, 4 tables, 45 references)

Dincer I. 2002
International Journal of Hydrogen Energy
27(3): 265-285

Department of Mechanical Engineering,
King Fahd University of Petroleum & Minerals,
PO Box 127, Dhahran 31261, Saudi Arabia
<idincer@kfupm.edu.sa>

Zinc-nickel alloy electrodeposits for water electrolysis

[245] An electrodeposited zinc-nickel alloy is used for the production of low hydrogen and oxygen overvoltage porous nickel electrodes in alkaline water electrolysis. In this study, electrodeposited zinc-nickel alloys of different compositions are evaluated as cathodes for alkaline water electrolysis. Alloys produced on electroformed nickel foils were etched in caustic to leach out zinc and to produce the Raney type porous electro catalytic surface for hydrogen evolution. The electrodes were examined by polarization measurements to evaluate their Tafel parameters and cyclic voltammetry, and to test the change in surface properties on repeated cycling and scanning electron microscopy to identify their microstructure and X-ray diffraction. The catalytic activity and the life of electrode produced from the 50% zinc alloy was found to be better than the others. (7 figures, 5 tables, 22 references)

Sheela G, Pushpavanam M, and
Pushpavanam S. 2002
International Journal of Hydrogen Energy
27(6): 627-633

Central Electrochemical Research Institute,
Karaikudi - 630 006, India
<malathypush@yahoo.com>

Hydrogen production by a new chemoheterotrophic bacterium *Citrobacter* sp. Y19

[246] Hydrogen production by a new chemoheterotrophic bacterium *Citrobacter* sp. Y19 is reported in this paper. *Citrobacter* sp. Y19 grows on organic carbons aerobically and produces hydrogen from carbon monoxide and water when transferred to anaerobic conditions. The hydrogen production capacity of Y19 was studied in serum-bottle and bioreactor cultures. The optimal conditions for hydrogen production were 30–40 °C and pH 5.5–7.5. The maximum hydrogen production activity was observed as 27.1 mmol/gcell hour, which was about three times higher than that of *Rhodospirillum rubrum*. In the bioreactor experiments, stable hydrogen production along with high activity of 20 mmol H_2/gcell hour was observed during continuous operation of 68 hours. (12 figures, 1 table, 28 references)

Jung G Y, Kim J R, Park J-Y, *et al.* 2002
International Journal of Hydrogen Energy
27(6): 601-610

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Other synthetic and natural fuels

Effect of activators and inhibitors on biogas production from water hyacinth

[247] The anaerobic treatment process is being recognized as a simple and energy-efficient means of treating and stabilizing different types of wastes. The process uses relatively simple equipment to directly produce an usual fuel and finds application in a variety of industries. The anaerobic digestion process seems to be ripe for further application. However, expert knowledge on activation process, digestion inhibition, and failures seems to be lacking. Additional work is required to deal with toxicity problems in

anaerobic waste treatment. The purpose of this study is to observe the effect of a small quantity of activators such as ammonium chloride, ammonium sulphate, and urea on the yield of biogas; and to determine the effect of inhibitors on system parameter(s), which signals the onset of digestion failure. It is further aimed that quantitative limits could be established for the inhibitors, which could be tolerated by anaerobic system without ill effects. It was also observed that a small quantity, i.e. one gram of activator increases the gas yield considerably. It was observed that ammonium sulphate happens to be the best activator and gives the maximum gas yield of 107.50 litres/kg of dried water hyacinth followed by ammonium chloride and urea yielding 68.10 litres/kg and 49.60 litres/kg, respectively, which were all higher than the 38.21 litres/kg in the control digester without activator. Copper was found to be the inhibitor and inhibits the process at a concentration of 125 mg/litre only. (12 figures, 6 references)

Ingole N W and Bhole A G. 2002
Journal of Institution of Engineers (India)-Environmental Engineering 82(March): 54-59

Department of Civil Engineering, College of Engineering, Badnera, Amravati - 444 701, India

Waste management and production of future fuels

[248] The disposal of biological wastes is a big problem due to its high transportation costs and the scarcity of dumping sites. Anaerobic degradation of these wastes to useful products like energy rich fuel gases can stabilize them and also serve as a renewable energy source. Biomass amenability to conversion depends largely on the characteristic of the biomass (substrate) and the process requirements of the conservation technology under consideration. The microbial production of hydrogen from waste biomass has been demonstrated but the yields are quite low, large-scale and continuous production is still in the incipient stage. This paper suggests that anaerobic digestion provides appropriate solutions to the problems associated with waste disposal and also generates biofuels as by-products. (9 figures, 13 tables, 104 references)

Raizada N, Sonakya V, Anand V, *et al.* 2002
Journal of Scientific & Industrial Research 61(3): 184-207

Centre for Biochemical Technology, Council of Scientific and Industrial Research, Delhi University Campus, Mall Road, Delhi - 110 007, India

Biomass

Fuelwood-fired cook-stoves in Sri Lanka and related issues

[249] The historical development of cook-stoves and ICS (improved cook-stove) development and dissemination programmes conducted in Sri Lanka are reviewed in this paper; and the current utilization patterns of different cook-stoves are estimated. The performance characteristics and the emission factors of the most commonly used stove categories are presented. The environmental and health implications of domestic cooking are discussed. Impacts of the dissemination of ICSs, in terms of fuelwood savings and emissions reductions, are also estimated. The results indicate that only 12% of the fuelwood used for cooking in the domestic sector is consumed in ICSs and around 41% of fuelwood could be saved by the dissemination of ICSs. This would lead to a considerable reduction in the emissions generated from fuelwood use in domestic cooking. (7 figures, 10 tables)

Perera K K C K and Sugathapala A G T. 2002
Energy for Sustainable Development 6(1): 85-96

Department of Mechanical Engineering, University of Moratuwa, Moratuwa, Sri Lanka

Identification of potential fermentation inhibitors in conversion of hybrid poplar hydrolyzate to ethanol

[250] The conversion of biomass to ethanol fuel involves the two-step process of hydrolysis and fermentation. The degradation products from the hydrolysis substantially inhibit the bioconversion

of sugar to ethanol. This paper presents an analytical procedure for identification of potential fermentation inhibitors in the conversion of hybrid poplar hydrolyzate to ethanol. More than 35 potential inhibitors to *S.cerevisiae* fermentation in dilute nitric acid hydrolyzates of hybrid poplar were identified. These were mainly aromatic aldehydes and acids, aliphatic aldehydes and acids, 3-4-dihydroxybenzoic acid, syringaldhyde, syringic acid, ferulic acid and 4-oxo-pentanoic acid. (5 figures, 8 tables, 31 references)

Luo C, Brink D L, and Blanch H W. 2002
Biomass and Bioenergy 22(2): 125-138

Forest Products Laboratory/Department of Chemical Engineering, University of California at Berkeley, Richmond Field Station, 1301 46th South Street, Richmond, CA 94804, USA <caidian.luo@jameshardie.com>

Hydrogen production from biomass by the gasification process

[251] The gasification of solid fuel to yield a mixture of H_2 and CO, followed by a water-gas shift conversion to produce H_2 and CO_2 are well-established processes. Renewable biomass has also been considered as a potential feedstock for gasification to produce syngas; the economics of the current process favour the use of light hydrocarbons (in natural gas) and coal. An alternative approach to the production of H_2 from biomass begins with fast pyrolysis and gasification of biomass. The study suggests that the production of hydrogen gas by biomass gasification with steam is enhanced by the addition of some inorganic salts to the reaction species. (3 tables, 25 references)

Demirbaş A. 2002
Energy Sources 24(1): 59-68

PK 216, 61035 Trabzon, Turkey
<ahyandemirbas@hotmail.com>

Rapeseed cake as a biomass source

[252] Cakes (meals) that are residential products derived from oil seed plants have a significant potential as a biomass source. In this paper the physical and chemical properties of rapeseed cake have been determined to find out its potential as a biomass source of fuel. The FTIR (Fourier Transform Infrared) analysis of a rapeseed cake was performed. The results show that rapeseed cake is rich in carbon and has great potential as a biomass source. Within the biomass energy technologies the rapeseed cake may be utilized either by direct combustion or by conversion processes. (5 figures, 2 tables, 6 references)

Çulcuoğlu E, Ünay E, and Karaosmanoğlu F. 2002
Energy Sources 24(4): 329-336

Department of Chemical Engineering, Istanbul Technical University, 80626 Maslak-Istanbul, Turkey <filiz@itu.edu.tr>

Biomass to bio-oil via fast pyrolysis of cotton straw and stalk

[253] In recent years fast pyrolysis process for production of bio-oils from biomass has attracted great deal of attention for maximizing yields. In this paper, fast pyrolysis of cotton straw and stalk to produce bio-oil has been discussed. Cotton straw and stalk were thermochemically processed by fast pyrolysis under different conditions in a fixed tubular reactor. The effects of pyrolysis temperature, heating rate, and sweep-gas rate were investigated in the experiments. The highest yield, 39.51%, was obtained at 550 °C final temperature, with heating and sweep-gas rates of 550 K/min and 200 cm^3/min respectively. The pyrolysis products and the sub-fractions of the pentane soluble were characterized by elemental analysis, gas chromatography, IR spectroscopy, and H-NMR spectroscopy. (9 figures, 4 tables, 13 references)

Pütün A E. 2002
Energy Sources 24(3): 275-285

Department of Chemical Engineering, Anadolu University, 26470 Eskişehir, Turkey, <aeputun@ anadolu.edu.tr>

Fuel characteristics of olive husk and walnut, hazelnut, sunflower, and almond shells

[254] In this work, fuel characterization such as proximate analysis, ultimate analysis, higher heating value and ash composition of shells from four oil seed plants (hazelnut, walnut, almond, and

sunflower) and olive husk were determined by analytical methods. The fuel properties for the combustion analysis of biomass can be conveniently grouped into physical, chemical, thermal, and mineral properties. The carbon content of selected biomass species varies from about 47.4%–53.5% due to varying lignin and extractives content. The hydrogen content of the species varies from 5.8%–6.7%. The oxygen content ranges from 35.5%–41.6%, sulphur is less than 0.1%, and nitrogen ranges from 0.5%–1.6%. Lignin content ranges from 17%–52.3%. The HHVs (higher heating values) of the selected samples were correlated with their lignin contents. There was a highly significant linear correlation between the HHVs of the samples and their lignin contents. (1 figure, 4 tables, 20 references)

Demirbaş A. 2002
Energy Sources 24(3): 215-221

PK 216, 61035 Trabzon, Turkey
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Chemical analysis and fuel properties of oils from oilseeds by supercritical fluid extraction

[255] The composition and the proportions of fatty acids in selected oilseeds growing in Turkey are determined in this paper. The dried and crushed samples were extracted in a standard Soxhelt extractor with acetone. During the SFE (supercritical fluid extraction) the samples were carried out in a 100 ml cylindrical autoclave for 60 min at 515 K and 6.6 MPa at above the critical temperature and the critical pressure of acetone. After the saponifcation, acidulation, and methylation procedures, methyl esters of the fatty acids from the Soxhlet and SFE were analysed by a Hewlett-Packard 5790 GC on a 12 m 0.2 mm capillary column coated with Carbowax PEG 20. The results conclude that while the yield of saturated fatty acids from SFE of the samples increased, the yield of linoleic acid decreased. The increases and decreases in the fatty acids were irregular. (1 figure, 3 tables, 14 references)

Yilmaz N, Sari H, and Demirbaş A. 2002
Energy Sources 24(4): 375-381

PK 216, 61035 Trabzon, Turkey
<ahyandemirbas@hotmail.com>

Utilization of urban and pulping wastes to produce synthetic fuel via pyrolysis

[256] The major by-products of the delignification processes of lignocellulosic biomass include lignin degradation products. Lignin and its degradation products have fuel values. The yields of liquid and gaseous products from the solid waste pyrolysis increase from 23.8% to 49.7% with temperatures increasing from 584 K to 683 K. The yields of liquid and gaseous products from the black liquor pyrolysis increased from 7.3% to 55% with temperatures increasing from 500 K to 800 K. The yields of liquid and gaseous products from pyrolysis of the solid waste and the black liquor samples increase with increasing temperature. This increase is very sharp for the yields of the liquid products from the solid waste at the same temperature range. (1 figures, 5 tables, 20 references)

Demirbaş A. 2002
Energy Sources 24(3): 205-213

PK 216, 61035 Trabzon, Turkey
<ahyandemirbas@hotmail.com>

Viability of biomass-fuelled cogeneration plants in paper mills

[257] A case study has been presented in this paper to examine the viability of using biomass fuels such as rice husk and bagasse in cogeneration plants in paper mills. The results show that using biomass fuels not only raises the overall thermal cycle efficiency but also helps in lowering CO_2 emission levels. The efficiency

Chakravarty M N. 2002
The Bulletin on Energy Efficiency 2(4): 24-26

Dimension Engineering Consultants Pvt. Ltd,
40/91, Chittaranjan Park,
New Delhi - 110 019, India
<manab2001@mantramail.com>

investment pattern showed very high profits in terms of its return in response. All the financial analyses such as DSCR analysis, payback period analysis, IRR (internal rate of return) analysis etc. justify that the implementation of this particular type of project has a very attractive rate of return and the risk involved in the project financing lies within tolerable limits. (1 figure, 1 table)

An overview of biomass pyrolysis

[258] Pyrolysis is the degradation of biomass by heat in the absence of oxygen, which results in the production of charcoal, liquid, and gaseous products. The pyrolysis process can be divided into three subclasses: conventional pyrolysis, fast pyrolysis, and flash pyrolysis. The hemicelluloses break down first at temperatures of 470 K to 530 K, cellulose follows in the temperature range of 510 K to 620 K, and lignin is the last component to pyrolyze at temperatures of 550 K to 770 K. If the purpose is to maximize the yield of liquid products resulting from biomass pyrolysis, a low temperature, a high heating rate, and a short gas residence time process would be required. For a high char production, a low temperature and a low heating rate process would be chosen. If the purpose is to maximize the yield of fuel gas resulting from pyrolysis, a high temperature, a low heating rate, and a long gas residence time process would be preferred. (3 figures, 5 tables, 32 references)

Demirbaş A and Arin G. 2002
Energy Sources 24(5): 471-482

PK 216, 61035 Trabzon, Turkey
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Thermochemical conversion of residual biomass to hydrogen for Turkey

[259] Thermochemical conversion processes such as pyrolysis, steam gasification, and decarbonization of lignocellulosic materials have the potential to be cost competitive with conventional means of producing hydrogen. Hydrogen will play an important role in a future energy economy mainly as a storage and transportation medium for renewable energy sources. Hydrogen may become the favoured energy carrier in a possible 'greenhouse driven' future due to its lack of CO_2 emission at the point of use. It is shown that decarbonizing fossil fuels to hydrogen with CO_2 being stored in deep geological formations represents the least expensive way of producing CO_2-free hydrogen. (2 figures, 4 tables, 21 references)

Sürmen Y and Demirbaş A. 2002
Energy Sources 24(5): 403-411

PK 216, 61035, Trabzon, Turkey
<ahyandemirbas@hotmail.com>

Project Gaia: converting biomass to a clean liquid fuel for domestic use

[260] Converting woody biomass including waste biomass into methanol, for use as an ideal clean-burning liquid fuel offers a cleaner and more efficient way to use biomass as the primary source for household energy. This paper discusses the technologies available to gasify biomass for methanol synthesis and likewise a technology to manufacture methanol from the synthesis gas on a small-scale. The opportunities for the developing countries that implement a methanol-based energy economy are discussed. The paper also discusses an energy efficient stove The Dometic Origo^R built by the Dometic Corporation that operates safely and effectively with methanol. (6 figures, 1 reference)

Ebbeson B, Stokes C A, and Stokes H. 2002
Energy for Sustainable Development 6(2): 43-48

Dometic, Zurcherstrasse 239, CH-8500
Frauenfeld, Switzerland
<bebbeson@bluewiun.ch>

Low greenhouse gas biomass options for cooking in the developing countries

[261] Large quantities of biomass fuels are used for cooking in the developing countries. Although biomass is a renewable source of energy, traditional biomass-fired stoves cause significant GHG (greenhouse gas) emissions due to the formation of products of incomplete combustion; also, exposure to the smoke from these stoves causes serious health problems. This paper presents an analysis of a number of selected options available for developing countries in the context of reducing total greenhouse gas emission per unit of useful energy for cooking. It is assumed that biomass as an energy carrier is CO_2-neutral. However, other GHGs emitted from biomass combustion cause a net greenhouse effect; accordingly, in this study only the non-CO_2 GHGs i.e., CH_4 and N_2O are considered in estimating GHG emission for different biomass-based cooking options. The total GHG emission from traditional wood-fired stoves is estimated to be about 110 g CO_2-e/MJ (grams of CO_2 equivalent per mega joule) of useful energy delivered to the cooking pot; this can be compared with 42, 5, 2, 350, 166, and 196 gCO_2-e/MJ of useful energy in case of improved wood-, biogas-, producer gas-, kerosene-, natural gas- and LPG-fired stoves respectively. Modern biomass based cooking options such as improved biomass-, biogas-, and producer gas-fired stoves can potentially play an important role in mitigating GHG emission from domestic cooking by providing an alternative to kerosene-, natural gas- and LPG-fired stoves.

Bhattacharya S C and Salam P A. 2002
Biomass and Bioenergy 22(4): 305-317

Energy Programme, Asian Institute of Technology, School of Environment, Resources, and Development, PO Box 4, Klong Luang, Pathumthani 12120, Thailand
<bhatta@ait.ac.th>

Optimization of biodiesel production by sunflower oil transesterification

[262] In this work the transformation process of sunflower oil in order to obtain biodiesel by means of transesterification was studied. Taguchi's methodology was chosen for the optimization of the most important variables (temperature conditions, reactants proportion, and methods of purification), with the purpose of obtaining a high quality biodiesel that fulfils the European pre-legislation with the maximum process yield. Finally, sunflower methyl esters were characterized to test their properties as fuels in diesel engines, such as viscosity, flash point, cold filter plugging point, and acid value. The results showed that the biodiesel obtained under the optimum conditions is an excellent substitute for fossil fuels.

Antolín G, Tinaut F V, Briceño Y, *et al.* 2002
Bioresource Technology 83(2): 111-114

Departamento de Ingeniería Química de la Universidad de Valladolid, Escuela Técnica Superior de Ingenieros Industralies, Paseo del Cauce, s/n. 47011 Valladolid, Spain

Wood energy

Role of woodfuel in household energy and its contribution to the rural socio-eonomy

[263] Cambodia is one of the poorest developing countries. The livelihoods of the people are based largely on agricultural production but this does not generate sufficient income to meet their needs. Thus they are forced to gather forest products for consumption and sale. This has resulted in considerable forest destruction. This paper discusses the role of fuelwood in the country's economy. The recommendations made to supply fuelwood on a sustainable basis are (1) establish community forestry to reduce uses of state owned forests, (2) develop the provinces' infrastructure to facilitate people to go to distant forests to collect

Kimly K. 2002
Regional Wood Energy Development Programme in Asia, pp. 42-47, Bangkok, FAO
[RWEDP Report No.61]

branches as fuelwood, (3) educate people to use the resources sustainably, and (4) increase the use of oil and gas to replace fuelwood for urban people. (9 tables)

Forestry Office of Kampong Speu Province, Cambodia

Modern applications of wood energy

[264] Wood is an important source of energy in the Philippines as its use is increasing. Recently, it has been tapped as a modern system for combined heat and power generation. This paper emphasizes the current technologies being applied in the Philippines for the utilization of wood for fuel and energy purposes. It is concluded that detailed assessments of the application of a particular wood energy conversion technology in specific locations are needed in order to establish the overall feasibility of the system.

Vinluan V. 2002
Regional Wood Energy Development Programme in Asia, pp. 101-105, Bangkok, FAO [RWEDP Report No.60]

Non-conventional Energy Division, Department of Energy, The Philippines

Assessing impact of extraction on sustainability of forests under joint forest management: a case study

[265] The impact of extraction on the sustainability of forests under JFM (joint forest management) in West Bengal has been assessed by comparing the productivity and extraction of non-timber forest products, in terms of biomass. The study conducted on the productivity of certain fuelwood producing species shows that perfect protection leads to the dominance of a particular species on the one hand and decreases the level of total production on the other. The earmarking of certain species for fuelwood by some forest protection committees has certainly some positive impact on forest ecosystem, but lack of attention towards a valuable species like *Bassia latifolia* leads to total elimination of the species. (1 figure, 3 tables, 7 references)

Mishra T K, Sahoo T, Bhuian A, *et al.* 2001
Annals of Forestry 9(2): 181-189

Raja N L Khan Women's College, Midnapur - 721 102, India

Joint forest management at village level: a cognitive analysis

[266] Effective local control of the forest department requires willingness and ability of the government to empower the people's local institutions and this empowerment is possible only when the people are aware of different roles and processes of JFM. In this regard, the cognitive analysis of JFM had been planned to study the level of knowledge and awareness of people towards JFM through the JFM Awareness Index. The results indicate a limited amount of cognitive level assimilation of JFM. This limited level of awareness and knowledge at a cognitive level acts as a constraint in the institutionalization of JFM. Thus, sustained awareness generating efforts are required at the micro-level through village workshops, study tours, exposure visits, educational campaigns, etc. to raise the level of knowledge and awareness of people towards the broader objective of institutionalization and sustenance of the JFM programme. (3 figures, 2 tables, 8 references)

Rishi P. 2002
The Indian Forester 128(5): 539-544

Indian Institute of Forest Management, Bhopal - 462 003, India

Optimizing acid-hydrolysis: a critical step for production of ethanol from mixed wood chips

[267] Ethanol can be produced from renewable lignocellulosic materials such as various types of natural wood. The cellulose contents of wood can be converted to ethanol in a two-step process where acid-hydrolysis converts cellulose to glucose sugars by hydrolysis (saccharification) and the resulting sugars can be converted to ethanol by fermentation. The main challenge of producing fuel

ethanol from renewable lignocellulosic biomass through acid-hydrolysis and fermentation is overcoming the cost-limiting factors associated with various stages of this technology. In this study, sugar recovery rates from a mixture of wood chips were investigated through three sets of acid-hydrolysis experiments. Wood chips were sorted to include equal ratios (by weight) of softwood and hardwood. Acid concentration and the heating period were the two main factors affecting dextrose yields. It was found that with the use of 26% by weight of sulfuric acid, highest dextrose yields could be reached within 2 hours of heating time. This corresponds to overall conversion efficiency of mixed wood chip cellulose to dextrose in the range of 78%–82% based on theoretical values. (1 figure, 2 tables, 9 references)

Iranmahboob J, Nadim F, and Monemi S. 2002
Biomass and Bioenergy 22(5): 401-404

The Environmental Research Institute, University of Connecticut, Route 44, Longley Building, 270 Middle Turnpike U-5210, Storrs, CT 06269-5210, USA

Wood fuel supply as a function of forest owner preferences and management styles

[268] The commercial demand for wood fuel is rapidly increasing in Sweden, and the domestic supply comes primarily from private non-industrial forest owners. A model was developed to analyse decision-making among these private forest owners. The model covers five factors: economics, transaction costs, concerns about soil fertility, forestry, and previous experience. It was applied in a survey among forest owners in four communities in central Sweden in 1999. Wood fuels had been sold from 60% of the estates. Analysis suggests that the price paid had little influence on the decision to sell. Transaction costs had been alleviated by the traditional timber buyer organizing the fuel trade, and by minimizing measurement in the forest. The primary reason for selling wood fuel was that the harvesting operation cleared the ground of debris. There is a general concern for the loss in soil fertility due to wood fuel harvesting which is why some owners do not sell forest fuels. Two types of fuel-selling forest owners were identified: (1) an active manager seeking different gains from the wood fuel harvest, and (2) an owner who primarily relies on the advice of the timber buyer. The findings indicate that large-scale traders of wood fuels have to be active in increasing supply, making direct contact with forest owners, and connecting trade with information on ecological and silvicultural effects. Offering ash recycling may enhance supply more than marginal price increases.

Bohlin F and Roos A. 2002
Biomass and Bioenergy 22(4): 237-249

Department of Forest Management and Product, Swedish University of Agricultural Sciences, PO Box 7060, SE-750 07 Uppsala, Sweden <folke.bohlin@sh.slu.se>

Wood energy and natural resources management in the Tonle Sap Basin

[269] The wood energy situation in Tonle Sap region of Cambodia is complex due to the different fuelwood balances for various ecological zones around the lake. It is difficult to quantify the exact fuelwood supply and demand per zone, and to estimate the fuelwood flow from both upland and inundated forest areas towards the more densely populated agricultural zone. The FAO (Food and Agriculture Organization of the United Nations) project Participatory Natural Resources Management in the Tonle Sap region was conceived in 1993 for the management of natural resources in the region. The results showed that the participatory approach, used by the project during collection of wood energy data and other data, allowed a better understanding of the dynamics, including people's needs and priorities. (1 table)

Hay S. 2002
Regional Wood Energy Development Programme in Asia, pp. 48-59, Bangkok, FAO. [RWEDP Report No.61]

Forestry Office of Siem Reap Province, Cambodia

Economic viability of short rotation coppice for energy production for reuse of caesium-contaminated land in Belarus

[270] Following the Chernobyl accident, changed land use such that the products of the land are radiologically acceptable and assure an economic return is a potentially sustainable remediation option. In this study, SRC (short rotation coppice) for energy production is evaluated as an alternative land use in contaminated areas. If the radiological and technical feasibility criteria are met, economic viability of the SRC wood production and conversion of the biofuel to energy are prerequisites for promotion of this alternative land-use. Data were collected for Belarus conditions and the economics of SRC production and conversion side were modelled using the Renewable Energy Crop Analysis Programme. The profitability of SRC production largely depends on crop yield, harvesting method, and price of the delivered biofuel; with labour and machinery cost playing a minor role. The required IRR of 5% at the production side is only obtained with high biofuel prices – 40 Euros per tonne – and a biomass yield of at least 6 T/ha (tonnes per hectare). For appropriate soil conditions, the potential SRC yields are high (10–12 T/ha per year). However, in Belarus, most soils are sandy for which yield estimates are too low (5 T/ha) to make production profitable. Cut and chip harvesting is more profitable than stick harvesting. On the conversion side, heat and power plant investment schemes are only profitable when industrial energy prices are considered. Systems are not viable at lower domestic rates with the IRR always being smaller than the 10% required for industry in Belarus. Large-scale heat conversion systems are the most profitable and revenue may be considerable with the IRR between 16% and 59%. Electricity routes are usually unprofitable. Waste disposal costs are only a small fraction of the total costs and revenue. (3 tables, 19 references)

Vandenhove H, Goor F, O'Brien S, *et al.* 2002
Biomass and Bioenergy 22(6)

SCKCEN, Boeretang 200, 2400 Mol, Belgium
<hvandenh@sckcen.be>

Wood energy production and trade in member countries: the need for its integration of forestry and related sectoral education in the Philippines

[271] Sustainable wood energy development requires the participation of local communities and private sector entrepreneurs, not only in forest protection and management but also to mobilize additional investment in non-forest land based wood-fuel production and modern bioenergy development. Therefore, the government policy in the member countries should encourage the participation of communities and private sector in wood energy development. Forestry and agroforestry training and education institutions in RWEDP (Rural Wood Energy Development Programme) member countries should also include wood energy into their curricula. This task may need technical assistance from the relevant national and regional agencies for the development of training aids, materials, and references covering different aspects of wood energy. (2 figures, 8 tables, 21 references)

Bhattarai T N. 2002

Regional Wood Energy Development Programme in Asia, pp. 15-53, Bangkok, FAO [RWEDP Report No.60]

WERS, RWEDP, FAO Regional Office for Asia and the Pacific, Maliwan Mansion, Phra Atit Road, Bangkok 10200, Thailand

The energy crop growth model SILVA: description and application to eucalyptus plantations in Nicaragua

[272] Energy crop yield is an important parameter for the performance of a biomass energy system, both from a financial and an environmental point of view. A crop growth model is a tool that can be used to estimate yields of energy crops in regions without

present experience with these types of crops. This study describes the crop growth model SILVA (silvicultural actual yield) model, which estimates the potential and the water-limited yields for a certain region on the basis of solar radiation, and daily data for precipitation and pan-evaporation. With the help of already available commercial yields of the same energy crop at a reference location, it makes an estimate for the actual yield that can be expected. The model was applied on plantations of *Eucalyptus camaldulensis* established for electricity generation at the San Antonio sugar mill in Nicaragua. On the basis of the harvest results of about 10 tonne$_{dm}$/ha/yr at the reference location, the Nicaraguan sugar mill Victoria de Julio, it was estimated that the *E. camaldulensis* plantation at San Antonio could produce about 13 tonne$_{dm}$/ha/yr, mainly because precipitation was higher. The data requirement of the model matched well with data availability in Nicaragua. (6 figures, 4 tables, 48 references)

van den Broek R, Vleeshouwers L, Hoogwijk M, *et al.* 2001
Biomass and Bioenergy 21(5): 335-349

Department of Science, Technology, and Society, Utrecht University, Padualaan 14,
3584 CH Utrecht, The Netherlands
<r.vandenbroek@ecofys.nl>

Fuel supply strategies for large-scale bio-energy projects in developing countries: electricity generation from agricultural and forest residues in Northeastern Thailand

[273] Agricultural and forest residues represent a major fuel source for potential bio-energy projects in many developing countries. However, a number of risks can threaten a secure fuel supply. This paper presents a methodology to set up fuel supply strategies for large-scale biomass conversion units (between 10–40 MW_e), and to determine the connected risks and to minimize them. The methodology focuses on variations in residue quantities produced, limited accessibility of residues, utilization by other competitors, and logistical risks. For each risk, possible ranges are determined and incorporated in different fuel supply scenarios which indicate how biomass quantities and prices may vary under different circumstances. The methodology was demonstrated in Northeastern Thailand. It is shown that process-based residues are already highly utilized, while the more expensive field-based residues represent the largest net available biomass potential. Both residue quantities and prices ($ 0.59–2.58 per GJ) can vary strongly, mainly depending on fluctuating harvests, increased utilization by competitors, and varying transportation costs. In the current Thai situation, only a state-of-the-art combustion plant seems to be able to operate economically on residues. It is concluded that assessing the risks connected to the fuel supply is vital for the successful operation of large-scale bio-energy projects. (9 figures, 5 tables, 33 references)

Junginger M, Faaij A, van den Broek R, Koopmans A, Hulscher W. 2001
Biomass and Bioenergy 21(4): 259-275

Department of Science, Technology, and Society, Utrecht University, Padualaan 14,
3584 CH Utrecht, The Netherlands
<m.junginger@chem.uu.nl>

Assessment of the potential of willow SRC plants for energy production in areas contaminated by radionuclide deposits: methodology and perspectives

[274] This paper assesses the suitability of willow SRC as a land-use alternative for farmlands contaminated by ^{137}Cs (radiocaesium) fallout from the Chernobyl nuclear power plant disaster. The Polessie district, a typical rural area located close to Chernobyl, was chosen as reference for the development of a GIS-based multidisciplinary approach combining maps of soil resources and ^{137}Cs deposits, modelling of SRC biomass production, and estimations of ^{137}Cs soil-to-wood transfer. From an agronomic viewpoint, the very dry sandy podzolic soils in the reference area are not suitable for SRC growing because they cannot supply

adequate water for SRC during the early summer period. Moreover, on the other soil types, both careful weeding and water supply during the early months after plantation are required, until both leaf cover and root system are sufficiently developed. From the radio-ecological viewpoint, and according to the local legislation, the SRC biomass produced on loamy sand, sandy loam and loamy soils is suitable for firewood. SRC biomass from the highly productive peaty soils – 39.4% of the land area of Polessie – may also be used but only if its conversion into heat or electricity is carefully managed. From an economic viewpoint, due to the very low local prices for fossil fuels, the gasification of SRC wood is at present not economically competitive with fossil fuels in Ukraine. Only strong political will and incentives could favour the implementation of bioenergy routes through subsidies and a major reorganization of the energy market. (6 figures, 5 tables, 31 references)

Goor F, Davydchuk V, and Ledent J F. 2001
Biomass and Bioenergy 21(4): 225-235

Radiation Protection Research Unit,
Radioecology Section, SCK-CEN, Boeretang,
200 B-2400 Mol, Belgium <fgoor@sckcen.be>

Hydro energy

A decomposition method for hydro generation scheduling

[275]

This paper presents an efficient decomposition method for finding the optimal operating policy of interconnected hydropower plants. In this approach the objective is to maximize hydropower generation. The coupling constraints on the reservoir storage at the end of the planning horizon are relaxed using coordinating multipliers, and interval-wise decomposing of the overall problem is carried out to reduce the complexity of the problem. The decomposed sub-problems are solved separately using augmented penalty function approach. An efficient heuristic algorithm is developed to find feasible solutions. A case study considering the scheduling of the Bhakra-Beas reservoir system is also presented in this paper. The method is found to perform better. (5 figures, 1 table, 9 references)

Naresh R and Sharma J. 2002
Journal of the Institution of Engineers (India)-
Electrical Engineering 82(March): 268-272

Department of Electrical Engineering,
Indian Institute of Technology Roorkee,
Roorkee - 247 667, India

Hybrid evolutionary programming solution to short-term hydrothermal scheduling problem

[276]

This paper presents a new two-phase hybrid evolutionary programming based solution method to the short-term hydrothermal scheduling problem. The proposed hybrid method is useful when addressing the heavily constrained optimization problem in terms of solution accuracy and computation time. The proposed method is developed in such a way that a standard evolutionary programming method acts as a base level search engine. The programming method makes a quick decision to direct the search towards the optimal region. Then the method of local optimization by direct search and systematic reduction in the size of the search region is employed to do fine-tuning. In order to validate the effectiveness of the proposed hybrid evolutionary programming method in solving the short-term hydrothermal scheduling problem, results were obtained for a test system with a hydro plant and an equivalent thermal plant for a time schedule of six 12-hour intervals. The results clearly demonstrate that the proposed hybrid evolutionary programming method not only improves the solution and reliability but also makes the algorithm more efficient in terms of the number of function evaluations to reach the global optimum point. The results also show the solution method as practical and valid for real-time applications. (2 figures, 6 tables, 11 references)

Baskar S, Subbaraj P, and Rao M V C. 2002
Journal of the Institution of Engineers (India)-
Electrical Engineering 82(March): 236-242

Department of Electrical Engineering,
Thiagarajar College of Engineering,
Madurai - 625 015, India

Prospect and potential of mini-micro and small hydel power in North Bengal

[277] A survey on the hydroelectric potential in West Bengal estimated a hydropower potential equivalent to about 2169 MW (excluding pump storage) of which a major portion exists in the Himalayan region of the Dooars area in North Bengal. The huge water power of the small rivers and streams in this area is virtually untapped. Mini-micro small hydel power has gained importance in recent times because it is pollution free and has low generation and transmission costs. The generated power serves as an essential input for the improvement of the socio-economic conditions of the local people and of the overall environment in the hilly areas. It is alarming that West Bengal has harnessed only 2.83% of its total hydro potential and only 5.44% of this potential is under development. A single generating station of the run-off river type can change the entire power scenario of this area. (7 tables, 4 references)

Das P K, Chanda R S, and Bhattacharya P K. 2002
Indian Journal of Power & River Valley Development 52(1&2): 31-39

Electrical Engineering, Jalpaiguri Government Engineering College, Jalpaiguri - 735 102, India

A methodology for forecasting of generation loss in storage power plants due to sedimentation

[278] The power generation of storage hydropower plants may decrease following gradual loss of storage capacity because of sedimentation in the reservoir. The paper presents a methodology to evaluate the future reservoir capacity following sediment deposition in the reservoir and the impact of reduced capacity on electrical energy generation. The methodology is simple and can be applied for assessing the power output of any storage power plant with respect to future storage capacity considering the sediment intake and the trap efficiency of the reservoir. This will give an idea of the additional electrical energy required to meet the deficit from the existing power plant. (4 figures, 4 tables, 12 references)

Sharma M G, Das D D, and Sharma J D. 2002
Indian Journal of Power & River Valley Development 52(1 and 2): 26-30

Water Resources Development Training Centre, Indian Institute of Technology Roorkee, Roorkee - 247 667, India

Solar energy

Design, development and implementation of data acquisition system for manufacture of solar photovoltaic modules

[279] Solar PV modules (single crystalline silicon-based) are manufactured by the electronics division of BHEL, Bangalore, for various applications such as electric power generation, street lighting, domestic lighting, water pumping, railways and road traffic signalling, and telecommunication. The I-V (current-voltage) characteristics of the manufactured modules are measured in a sun-simulator (module tester). Since the I-V measurement is a 100% routine test, a need was felt to share the measured data (for easy retrieval, analysis, and test reporting) by interfacing the module tester with a PC. For measurement and storage of the above I-V data, a PC-based DAS (data acquisition system) has been designed and developed in-house. The DAS comprises the complete set of hardware and software components required for interfacing with the PV module tester, such as a signal conditioner, ADC (analog-to-digital converter), and a feedback circuit. The software is written in Power Builder (Version 5.0) and works on the Windows 95 platform. The data acquired is logged and managed by the software for statistical analysis and presentation, which also employs suitable mathematical models for polynomial curve fitting. The system was commissioned in November 1999, and has since then been in operation. (6 figures)

Ashok E, Venkatesh K, Ravi S, *et al.* 2002
BHEL Journal 23(1): 25-33

Editor, BHEL Journal, Bharat Heavy Electricals Ltd, BHEL House, Siri Fort, New Delhi - 110 049, India

Scope of fertilizer solar ponds in Indian agriculture

[280] The feasibility of using fertilizer salts in the place of sodium chloride for operating solar ponds has been studied in this paper. The study of fertilizer consumption pattern in India identified MoP (muriate of potash) and urea as the potential salts for solar ponds. MoP, because of properties similar to that of sodium chloride has the capacity to provide energy at a cheaper price and also provide fertilizer to crops. Future studies will have to be conducted using this salt rigorously under simulated and prototype conditions before it is introduced on a large scale in solar ponds. (3 figures, 2 tables, 28 references)

Murthy G R R and Pandey K P. 2002
Energy: The International Journal **27**(2): 117-126

Department of Agricultural Engineering, Directorate of Rice Research, Rajendranagar, Hyderabad - 500 030, India
<grk@drr.ap.nic.in>

Exploitation of solar energy collected by solar stills for desalination by membrane distillation

[281] The production of potable water from simulated seawater using solar-powered membrane distillation has been investigated in this paper. The solar still has been used for both brine heating and potable water production. The effects of temperature, brine flow rate, salt concentration, and solar irradiation on the distillation process were tested. It was found that the contribution of the solar still in the distillate production was no more than 20% of the total flux in the outdoor experiments and less than 10% of the total flux in the indoor experiments. The brine flow rate significantly affected the flux of the membrane module, while the effect of the salt concentration was marginal. The effect of these process parameters was more noticeable in the membrane module than in the solar still. (8 figures, 1 table, 14 references)

Banat F, Jumah R, and Garaibeh M. 2002
Renewable Energy **25**(2): 293-305

Department of Chemical Engineering, Jordan University of Science and Technology, Irbid - 22110, Jordan <banatf@just.edu.jo>

Solar-hybrid gas turbine-based power tower systems (REFOS)

[282] Solar hybrid power plants have a potential for cost reduction when solar energy is introduced in a gas turbine system. The introduction into gas turbine system could be realized with pressurized volumetric air receivers. This paper discusses the work done by the REFOS project, Plataforma Solar de Almería, Spain, to develop, build, and test modular pressurized volumetric receivers under representative operating conditions for the coupling with gas turbines. Several configurations of solar-hybrid gas turbine cycles in the low to medium power range are also examined for performance and costs. The results confirm the promising potential of this technology to reach competitiveness in certain power markets. (14 figures, 6 tables, 12 references)

Buck R, Bräuning T, Denk T, *et al.* 2002
Journal of Solar Energy Engineering **124**(1): 2-9

DLR-ITT, Pfaffenwaldring 38-40, D-70569, Stuttgart, Germany
<reiner.buck@dlr.de>

A new trough-like non-imaging solar concentrator

[283] A new two-dimensional concentrator for solar energy collection has been developed in this paper. The advantages of the new concentrator when compared with the classic compound parabolic concentrators are that (1) it allows the use of parabolic mirrors which have a reflecting area much smaller for a given concentration ratio and acceptance angle, (2) between the mirror and the absorber, there is a large gap so that the conduction losses are reduced, and (3) it can be easily manufactured. This concentrator could have many practical applications, such as fluid heating, steam generation etc. (6 figures, 1 table, 7 references)

Rincón E A and Osorio F A. 2002
Journal of Solar Energy Engineering **124**(1): 51-54

Facultad de Ingenría, Universidad Autónoma del Estadó de México, Cerro de loatepec CU, 50130 Toluca, Mçxico
<erincon@coatepec.uaemex.mx>

Optimal sizing procedure for stand-alone photovoltaic systems by fuzzy logic

[284] In this paper an automatic procedure to perform the optimal sizing of a stand-alone solar electrical system with battery storage is developed by a fuzzy logic based multi-objective optimization approach. The procedure aims at finding the configuration that yields the best compromise for the two considered objectives: the long-term average performance and the overall cost of the generating system. The control variables are the solar cell array surface, the tilt angle of the modules, and the storage system capacity. The fuzzy multi-objective optimization procedure is described and the application results are presented considering different configurations characterized by some parameters, such as the electrical load, the yearly power demand, the distance from the utility grid, and the unit cost of solar cells. (4 figures, 6 tables, 12 references)

Conti S, Tina G, and Ragusa C. 2002
Journal of Solar Energy Engineering **124**(1): 77-82

Dip. Elettrico, Elettronico e Sistemistico,
Università di Catania, Viate Andrea doria n.6,
95125 Catania, Italy <sconti@dees.unict.it>

Performance of solar fruit drying system

[285] A considerable amount of the fresh fruits produced in Pakistan are wasted every year due to the non-availability of basic post harvest technologies. To overcome this problem a solar fruit drying system was designed and developed at the Farm Machinery Institute, Islamabad. The system consists of six flat-plate solar collectors, an axial flow fan, and a drying chamber. The performance of the system was evaluated at Nalkot, Swat, Pakistan where persimmon was available in enough quantity for drying. It was observed that the solar collectors raised the average daily temperature for the ambient air from 26–44 °C. However, the hot air within the drying chamber was not distributed uniformly. The average daily efficiency of the solar collectors was 44%. The solar dryer was capable of processing about 1–1.5 tonnes of fresh persimmon in one month, whereas the farmers wanted to increase its drying capacity up to 4–5 tonnes per month. It was concluded that the drying chamber would be redesigned, and a supplementary source of heat (gas- or oil-fired) would be provided to the solar dryer in order to increase its drying capacity. (9 figures, 5 tables, 8 references)

Ahmad M. 2001
Journal of Engineering and Applied Sciences 20(2): 45-52

Farm Machinery Institute, National Agricultural
Research Centre, Islamabad, Pakistan

System sizing for solar photovoltaic water pumping

[286] The new technology of solar powered water pumps is gaining importance these days. It has been observed that most of the water pump suppliers will size the pump for a given location and water demand, but it is advisable to carry out economic assessment of solar pumping viability and to estimate the required system size before inviting proposals from suppliers. This paper describes how to estimate the approximate solar water pumping system size, which includes size of PV array, motor, pump, and pipe work. (2 figures, 3 tables, 6 references)

Mahar F. 2001
Journal of Engineering and Applied Sciences 20(2): 58-63

Department of Electrical Engineering,
Balochistan University of Engineering and
Technology, Khuzdar-Balochistan, Pakistan

Solar water systems—design and performance

[287] The amount of hot water a solar heater produces depends on the type and size of the system, incident solar radiation, installation of the system, etc. Yet simply positioning the collectors so that they receive maximum annual radiation does not necessarily result in maximum system effectiveness. This paper provides a useful overview of the system designs of the solar water heaters and comments on their comparative performances. (15 figures, 7 references)

Morrison G L. 2002
Renewable Energy World 5(2): 111-119

School of Mechanical and Manufacturing
Engineering, University of New South Wales,
Sydney, Australia <g.morrison@unsw.edu.au>

Long-term monitoring of photovoltaic devices

[288] The performance and degradation of PV devices, and the effect of meteorological conditions on device performance over extended periods have been monitored in this study. The degradation mechanisms of PV devices are also discussed. The study showed that the power ratings of PV devices do not usually give an accurate indication of their performance outdoors. The results also showed that the meteorological conditions could cause an 18% reduction in a module's potential power. A comparative study on the PV concentration module showed that the concentrator module produced much less energy than its rated energy when operating outdoors. The energy performance of a tracked flat plate module vastly exceeded the concentrator module's performance. (11 figures, 2 tables, 13 references)

van Dyk E E, Meyer E L, Vorster F J, *et al.* 2002
Renewable Energy 25(2): 183-197

Department of Physics, University of Port
Elizabeth, PO Box 1600, Port Elizabeth 6000,
South Africa <phaevd@upe.ac.za>

A 21.5% efficient Cu(In,Ga) Se$_2$ thin-film concentrator solar cell

[289] The CIGS - Cu (In,Ga)Se$_2$ - solar cells have been designed for operation under mildly concentrated sunlight. The absorber was deposited via a three-stage evaporation process that has consistently yielded high-performance one-sun devices. The device structure reported here was modified by reducing the thickness of the CdS window/buffer layer to enhance the short-circuit current at the expense of the open-circuit voltage. Operation of the devices under optical enhancement leads to significant increase in the voltage and fill factor. At 14 suns the open circuit voltage for this device was 736 mV, the fill factor was 80.5%, and the efficiency was 21.5%. This result represents the first report of a polycrystalline thin-film solar cell with an efficiency in excess of 20%. (4 figures, 7 references)

Ward J S, Ramanathan K, Hasoon F S,
Coutts T J, Keane J, Contreras M A, Moriarty T,
Noufi R. 2002
Progress in Photovoltaics: Research and Applications 10(1): 41-46

National Renewable Energy Laboratory,
Golden, CO 80401, USA
<scott_ward@nrel.gov>

Laser-fired rear contracts for crystalline silicon solar cells

[290] From today's viewpoint future solar cells will be thinner, of higher efficiency, and produced in greater numbers. A solar cell concept able to fit these developments could be the passivated emitter and rear cell. With a new laser-based process (laser-fired contacts), the rear point contact pattern of this concept can be implemented industrially. After the deposition of a dielectric passivation layer and a metal layer on top, an Nd-YAG laser is used to alloy the contact points through the dielectric layer. Excellent efficiencies have been achieved which approach close to those of reference cells processed by photolithography. This demonstrates the high potential of the new laser-based technique. (4 figures, 11 references)

Schneiderlöchner E, Preu R,
Lüdemann R, *et al.* 2002
Progress in Photovoltaics: Research and Applications 10(1): 29-34

Fraunhofer Institute for Solar Energy Systems,
Heidenhofstrasse 2, 79110 Freiburg, Germany
<eric.schneiderloechner@ise.fhg.de>

Performance analysis of a solar cooker in Turkey

[291] A box-type solar cooker is designed and its thermal performance is analysed experimentally in this paper. The cooker tracks the sun in two axes, altitude, and sun azimuth, by hand control for hourly periods. The experimental results show that the tested cooker may be suitable in some cooking processes for specific country conditions. (7 figures, 13 references)

Oturanç G, Özbalta N, and Güngör A. 2002
International Journal of Energy Research 26(2): 105-111

Department of Mathematics, Selçuk
University, 42079 Kampüs, Konya, Turkey
<goturanc@selcuk.edu.tr>

Economic viability of stand-alone solar photovoltaic system in comparison with diesel-powered system for India

[292] In this paper the economic viability of a stand-alone PV system in comparison to the most likely conventional alternative system, i.e. a diesel-powered system, has been analysed for energy

demand through sensitivity analysis. The analysis shows that PV-powered systems are the lowest cost option at a daily energy demand of up to 15 kWh, even under unfavourable economic conditions. When the economic parameters are more favourable, PV-powered systems are competitive up to 68 kWh/day. These comparisons are intended to give a first-order indication of when a stand-alone PV system should be considered for application. As the cost of a PV system decreases and diesel cost increases, the break-even point occur at higher energy demand. (4 figures, 1 table, 7 references)

Kolhe M, Kolhe S, and Joshi J C. 2002
Energy Economics 24(2): 155-165

Maulana Azad College of Technology, Regional Engineering College, Bhopal - 462 007, India
<mpkolhe@yahoo.com>

Reliability evaluation of solar photovoltaic arrays

[293] The operational lifetime of large solar PV arrays is investigated using the probability theory for the assessment of reliability. Arrays based on the following three solar cell interconnection schemes have been considered: (1) the simple SP (series-parallel) array, (2) the TCT (total-crossed-tied) array which is obtained from the SP array by connecting ties across each row of junctions, and (3) the BL (bridge-linked) array in which all cells are interconnected in bridge rectifier fashion. To evaluate the reliability of the BL configuration, the cut-set technique is used. Computational results based on arrays consisting of (720 x 20) solar cells indicate that the operational life of an array is almost doubled by the introduction of cross ties (TCT or BL scheme) in the array. The operational lifetime can be further increased by ~30% by modularized networks based on TCT and BL configurations. However, these results are based on a theoretical analysis and not on measured efficiency and life expectancy of solar cells. (13 figures, 20 references)

Gautam N K and Kaushika N D. 2002
Solar Energy 72(2): 129-141

Centre for Energy Studies, Indian Institute of Technology Delhi, Hauz Khas, New Delhi - 110 016, India
<ndkaushika@yahoo.com>

CPC type integrated collector storage systems

[294] The design, construction, and experimental results of the CPC (compound parabolic concentrating) reflectors for the ICS (integrated collector storage) solar water heaters have been presented in this paper. The system design consists of single and double cylindrical horizontal tanks properly placed in truncated symmetric and asymmetric CPC reflector troughs. The suggested design aims to achieve low cost system with improved performance by the reduction of their thermal losses, and the increase of water temperature rise by using the non-uniform distribution of solar radiation on the absorber surface. Four experimental models were constructed and tested outdoors to determine their mean daily efficiency and thermal losses during night. Test results showed that asymmetric CPC reflectors contribute to lower thermal losses and the two connected in series in cylindrical storage tanks result in effective water temperature stratification. (18 figures, 3 tables, 36 references)

Tripanagnostopoulos Y, Souliotis M, and Nousia T. 2002
Solar energy 72(4): 327-350

Department of Physics, University of Patras, Patra 26500, Greece
<yiantrip@physics.upatras.gr>

Wind energy

Economic viability analysis of planned WEC system installations for electrical power production

[295] A general and systematic procedure has been developed in this paper for evaluating the economic viability of investment plants for the WEC (wind energy converter) system installations used for power production. The procedure is based on the assessment of the wind energy potential of an area, the limitations involved

in selecting sites, the technical specifications of a candidate WEC system, etc. This process was applied successfully to an area of the north-eastern part of Greece (the Thrace region). Investigations showed that with respect to the present national energy and economic development laws, installations of medium size WEC systems (150–500 kW) are favoured for the case of independent producers over auto producers. (16 figures, 4 tables, 12 references)

Papadopoulos D P and Dermentzoglou J C. 2002
Renewable Energy 25(2): 199-217

Electrical Machines Laboratory, Department of Electrical and Computer Engineering, Democritos University of Thrace, 671000 Xanthi, Greece <dpapadop@ee.duth.gr>

Electric load-brake control for a small wind-turbine operating in mountainous winds

[296]

The wind turbines situated in mountainous areas often suffer from over-speeding due to highly gusty mountainous winds with high shear. This paper presents a study to contribute to the operation and control of wind turbines situated in mountainous areas. The study suggests that by adding an electric load-brake to the conventional pitch control, over-speed can be suppressed and power production can be increased. (10 figures, 1 table, 6 references)

Ichikawa Y, Nishioka M, Takami H, Kimura S. 2001
Wind Engineering 25(2): 71-80

Sumitomo Precision Products, Amagaskai, Hyogo 660-0891, Japan <ichika-y@spp.co.jp>

A review of the economics of offshore wind farms

[297]

This paper describes the economics of offshore wind energy in the transition from prototype offshore wind farms, developed and installed during the 1990s, to the commercial wind farms that are currently being installed. Since 1990, 96 MW of offshore wind have been installed in Europe. The costs of electricity produced from these plants have fallen from almost twice that of equivalent land sites, to the point where the best offshore wind farms compete with moderate onshore locations. The transition to increasing economic viability and the factors that may influence the feasibility of offshore developments in the future have been discussed in this paper. (3 tables, 40 references)

Barthelmie R J and Pryor S. 2002
Wind Engineering 25(3): 203-213

Department of Wind Energy, Risø National Laboratory, 4000 Roskilde, Denmark <r.barthelmie@risoe.dk>

Substitution potential of wind energy in Egypt

[298]

The evaluation of the substitution potential of wind energy by generation planning of power systems is becoming an important task. This paper presents a new methodology for estimating the capacity credit due to wind generation based on the convolution technique considering the statistical wind speed variations. The economic impact of wind energy is also assessed in the form of a cost-benefit ratio to justify the substitution potential of such a clean energy resource. The feasibility of the proposed approaches is illustrated using the planned 600 MW wind farm in Za'afarana district along the Red Sea. The paper concludes that the proposed wind farm was judged feasible from the environmental and economic points of view. In order to maximize the feasibility of the farm, it is recommended that more wind data measured at representative locations of the proposed farm site be collected. (2 figures, 6 tables, 15 references)

El-Sayed M A H. 2002
Energy Policy 30(8): 681-687

Electrical Power and Machines Department, Cairo University, Egypt <elsmah@alpha1-eng.cairo.enu.eg>

Electric power engineering

Estimation of technical losses in a distribution system

[299]

The power sector in India is undergoing unprecedented changes. The state electricity boards, which have been accumulating losses year after year, are undergoing reforms and getting restructured as profit centres. The distribution sector is being handed over to private companies. In this new scenario, there is a need to study the distribution network in greater detail. This paper describes the outcomes of the distribution studies for major towns of Karnataka, India, carried out by the Central Power Research Institute, Bangalore; points to the causes of high technical losses in the system; and suggests remedial measures to reduce the losses. (1 reference)

Sarkar B N, Channakeshava, and Gopal H R. 2001
Vidyut Bharati 24(2): 9-13

Central Power Research Institute, New BEL Road, PO Box 8066, Bangalore - 560 080, India

Minimum stack height formula for coal-based thermal power plants in northern India

[300] An air-quality prediction exercise was carried out with ISC model using meteorological data from four industrial towns (Jagdishpur, Panipat, Mathura, and Satna) in northern India for different SO_2 emission rates from coal-based thermal power plants of 110 MW and 500 MW. The physical stack height required for the different SO_2 emission loads so as to fulfil the regulatory requirement of ambient air quality was determined. The SO_2 emission loads (X-axis) were plotted against physical stack heights (Y-axis) for all the scenarios considered. Regression analysis was carried out for each data set and a separate empirical equation was determined for physical stack height as a function of the SO_2 emission rate. It was found that each scenario is represented by a different trend/equation. Since the ground level concentration of the pollutant is a function of the exit velocity of flue gas and the stack top diameter, which varies for different capacities of the power plant, the stack height formula is generated for 110 MW and 500 MW capacity thermal power plants separately. The equation is compared graphically with the currently used unique minimum stack height formula. The study demonstrates that a single empirical formula for the physical stack height of thermal power plants as a function of only one independent parameter (the SO_2 emission load) excluding other factors (stack top diameter, flue gas exit velocity, and temperature) for a region (India) marked by non-uniform meteorology cannot be considered appropriate. For an air shed that can be represented by a reasonably uniform meteorology, a stack height formula can be developed, which is a function of source parameters. If source parameters can be categorized as in the case of thermal power plants (110 MW and 500 MW) separate formula can be generated for each source category.
(4 figures, 2 tables, 6 references)

George K V, Rao C V C, Labhsetwar P K, *et al.* 2002
Journal of the Institution of Engineers (India)- Environmental Engineering **82**(March): 31-34

National Environmental Engineering Research Institute, Nehru Marg, Nagpur - 440 020, India

Corrective rescheduling of reactive power control variables using static voltage stability index

[301] This paper presents a new methodology for the enhancement of voltage security using a voltage stability index. The objective function is the minimization of the reactive power injection, which is of prime importance for maintaining the desired level of voltage security. A linearised incremental model has been used. A linear set of co-ordination equations have been obtained whose direct solution gives the optimal reactive power control corrections to achieve the desired optimized solution. The algorithm developed has been implemented on a sample test system. The proposed approach based on an incremental model has the potential to be implemented in real time and gives closed form relations for the reactive power control variables in terms of the base case sensitivities. (6 tables, 13 references)

Arya L D and Choube S C. 2002
Journal of the Institution of Engineers (India) 82(March): 227-231

Department of Electrical Engineering, Shri G S Institute of Technology and Science, Indore - 452 003, India

Reducing losses in power system through advanced power electronics—the developmental efforts in BHEL

[302] In an electrical transmission and distribution system, losses can be controlled by improving the quality of power. Power electronics has now provided tools to improve system voltage, regulate power flow through lines, and achieve reactive power balance, thereby reducing system losses. The paper highlights the advanced energy conservation and power quality improvement projects under execution by BHEL using high power electronic devices. These projects come under the classification of FACTS (flexible AC transmission system). (4 figures)

Tripathy A K. 2002
BHEL Journal 23(1): 8-15

Editor, BHEL Journal, Bharat Heavy Electricals
Ltd, BHEL House, Siri Fort,
New Delhi - 110 049, India

Engineering electrical protection system for combined-cycle power plant—specific aspects

[303] The protection philosophy and schemes for unit protection as well as auxiliary power distribution for combined-cycle power plants differ in some aspects from those for conventional coal-based power plants. This paper presents specific protection aspects of combined-cycle power plants. Gas turbine generator protection, effect of generator circuit breaker on protection philosophy, classification of tripping, start-up frequency converter related protection, 'black start' diesel generator protection, and high voltage switchgear related protection are discussed. The need for collection of systematic feedback data from various sites in the country is also emphasized, with an objective to achieve standardization. (1 figure)

Chawla R S, Khurana K K,
Subramanian G, *et al.* 2002
BHEL Journal 23(1): 16-23

Editor, BHEL Journal, Bharat Heavy Electricals
Ltd, BHEL House, Siri Fort,
New Delhi - 110 049, India

An overview of advanced space/terrestrial power generation device: AMTEC

[304] The AMTEC (alkali metal thermal electric converter) technology offers several advantages over conventional forms of electricity generation. Some of these advantages are high efficiency, high density, reliability, absence of moving parts, and competitive manufacturing costs. These and other advantages make AMTECs ideally suited for several space, aerospace, military and domestic applications. Current AMTEC designs suffer from some drawbacks that need to be rectified if the full potential of the technology is to be realized. These drawbacks include the gap between current cell efficiencies and the theoretically possible values, and the adverse power-time characteristic of the cell. This paper discusses in detail the advantages of AMTEC technology and the problems with the current designs. In particular, the problem of power degradation is dealt with in some detail and some measures are suggested that will help arrest this loss of power with time. (4 figures, 1 table, 29 references)

Lodhi M A K, Vijayaraghavan P, and Daloglu A.
2001
Journal of Power Sources 103(1): 25-33

Lexel Corporation, 4000 S. Saginaw, Building.
E, Suite 180, Flint, MI 48507, USA
<b5mak@ttacs.ttu.edu>

A new method of energy degradation on-line analysis for coal-fired units—expansion line approximating method

[305] An energy degradation analysis process of unit and thermal systems for coal-fired power plants, under discrete conditions when load has been changed greatly, is discussed in this paper. A new expansion line approximating method, which can rationally calculate the quantity of every component of energy degradation and identify the places where energy degradations arise, is put forward. In addition, the quality of every component of energy degradation is also discussed. The analysis of the actual operation shows that the method is very reliable under a large load scope (50%–100% rated output). (6 figures, 2 tables, 3 references)

Cao X, Zhang C, and Jiang A. 2002
Applied Thermal Engineering 22(3): 339-348

Department of Energy Source Engineering,
Shaihai Jiaotong University, Shanghai
200240, China <xc_cao@hotmail.com>

Energy-like functions for transient analysis of multimachine hybrid power systems

[306] An new energy-like function for a power system supplied by synchronous and induction generators has been developed. This paper proves that the rotor angle for the induction machine can also play an important role in the analysis of the transient stability of power systems, contrary to all the earlier statements. The simulation results from the obtained energy-like functions are found to be in close agreement with results from step-by-step integration, showing that with improved studies, stability analysis of power systems – including induction machines – can be performed on equal footing with the traditional case of basing all judgement on the dynamics of synchronous machines. These results may be extended to the general case of power systems supplying induction motor loads. Future work will deal with larger power systems and with detailed representation of the loads. (4 figures, 1 table, 12 references)

Munda J L and Miyagi H. 2002
International Journal of Power and Energy Systems 22(1): 8-15

Graduate School of Science & Engineering, University of the Ryukyus, 1 Senbaru, Nishihara-cho, Okinawa 903-0213, Japan
<munda@sys.ie.u-ryukyu.ac.jp>

Optimal connections between distribution transformers and a primary feeder considering harmonic distortion

[307] A new genetic-based approach for optimal connections between distribution transformers and a primary feeder considering harmonic distortion is presented in this paper. The goal of this approach is to determine optimal connections between distribution transformers and a primary feeder such that the power losses, voltage unbalancing, and harmonic voltage distortions can be greatly reduced. The harmonic voltage distortion limits, voltage magnitude limits, and low energy over current relay current limit are fully taken into account. For the analysis of unbalanced distribution systems while changing the connections of transformers, the equivalent individual phase loads are derived. Simulation results on a 28-bus actual system demonstrate the effectiveness of the proposed approach. (9 figures, 2 tables, 7 references)

Chang H C and Chang T T. 2002
International Journal of Power and Energy Systems 22(1): 16-21

Department of Electrical Engineering, National Taiwan University of Science and Technology, 43 Keelung Road, Sec. 4, Taipei, Taiwan, ROC
<hcchang@mail.ntust.edu.tw>

Energy planning and policy

Restructuring and privatizing electricity industries in the commonwealth of independent states

[308] The reasons for privatizing electric power are to attract needed foreign capital investment, to increase efficiency, and to rationalize resource allocation. This paper discusses the problems of privatizing the electric power sectors in the countries of the CIS (Commonwealth of Independent States) and examines in detail the privatization of electricity utilities in Armenia. The paper argues that in the countries of CIS little progress has been made, because given the volume of spare capacity, the investment needs of the electricity industry are not great compared with the strategic and potential benefits to be had by not privatizing. Specific measures that can be taken to increase investor confidence include raising tariffs to economic levels and making the operation of both the dispatch and the wholesale power markets transparent and accountable. (1 table, 33 references)

Anex R P. 2002
Energy Policy 30(5): 397-408

Science and Public Policy Programme, University of Oklahoma, 100 East Boyd Street, Room S-202, Norman, OK 73019, USA
<rpanex@ou.edu>

A review of the energy policy in Sri Lanka and its implementation

[309] In the energy sector of Sri Lanka, ad-hoc decisions are more the norm than carefully planned and analysed actions. The energy

policy document prepared in 1997 has been accepted by the Ministry of Energy, but it has not been translated into a plan of action. Recent decisions on various aspects of the electricity and petroleum sub-sectors do not reflect adherence to the energy policy. Inaction on several vital issues, particularly on renewable energy and energy pricing, also shows that the energy policy in Sri Lanka is confined to a report. (12 figures)

Siyambalapitiya T. 2002
Energy for Sustainable Development 6(1): 5-13

Resource Management Associates (Pvt) Ltd, No.3 Charles Terrace, Colombo 3, Sri Lanka

Biogas – a review of Sri Lanka's performance with a renewable energy technology

[310] Sri Lanka's experience with a renewable energy technology, namely biogas, is reviewed in this paper. The discussion looks at biogas technology as adapted and utilized in Sri Lanka. It is shown that the technology has received attention from the initial days of the energy crisis in 1973, including a Colombo Declaration calling for regional development of biogas technology. However, there has been limited popularization and application of biogas in the country. Biogas systems have been promoted for their capability to provide lighting and for cooking, both energy needs, and then as a way to produce bio-fertilizer from solid waste streams for agricultural needs. Biogas systems, used and in use, are identified and the reasons for their failures are summarized. The ways in which the process has been promoted are also considered and it is seen that the container approach has been given more weightage than the process itself. The process, taking place during biogasification has been largely ignored and taken for granted in the dissemination of the technology. Also shown is the fact that promises made in trying to get the technology accepted are impossible to fulfil when a simple analysis is performed. This is shown with respect to the cattle owning families of Sri Lanka. The paper concludes with the recent development in attempts to introduce biogas systems in the country. From a developing country perspective the paper argues that the ways in which this technology has been promoted are unacceptable. Biogas utilization can take place professionally if a systematic approach is adopted and if the advocates look at the technology in an objective manner. The paper also suggests that images such as *biogas is from wastes* and *this energy is for rurals* need to be discarded. (4 tables, 10 references)

de Alwis A 2002
Energy for Sustainable Development 6(1): 30-37

Department of Chemical and Process Engineering, University of Moratuwa, Moratuwa, Sri Lanka

Examining alternatives: the energy services delivery project in Sri Lanka

[311] Decentralized renewable energy production is becoming a more acceptable and widely-used form of electricity generation. In 1997, the World Bank signed an agreement with the Government of Sri Lanka to initiate an ESD (energy services delivery) project. Stakeholders participating in the ESD project hold different views of the project based on their location within the project hierarchy. Using an interpretivist methodological approach, the author elucidates the shared and divergent meanings between two stakeholder groups: the private-sector banking officials and the end-users. Stakeholder understandings of the project organized themselves around three emergent themes: risk, responsibility, and sustainability. Understanding how stakeholders conceptualize these three concepts provides valuable insight into how long-term cooperative energy policy and delivery services might be designed. (1 figure, 1 table, 18 references)

Caron C M. 2002
Energy for Sustainable Development 6(1): 38-46

Department of Rural Sociology, Cornell University, 118 Warren Hall, Ithaca, NY 14853, USA <cmc41@cornell.edu>

Energy and environmental correlation for renewable energy systems in India

[312] The cumulative energy demand and cumulative greenhouse effect for three renewable energy technologies – wind energy, SPV, and SWH (solar water heating) system – corresponding to typical climatic conditions in India have been calculated in this paper. The life cycle assessment of these systems (1.5 MW wind mill, 35Wp SPV, 2 m^2 and 100 L SWH systems) has yielded the parameters' EYR (energy yield ratio) and emission coefficients. The EYRs for the wind energy, SPV, and SWH technologies are found to range from 9.59 to 31.11, 0.58 to 0.91, and 2.32 to 7.14 respectively. The variations of the emission coefficients are from 2.40 to 7.86, 83.72 to 133.10, and 19.88 to 61.06 Kg CO_2 per G J delivered from these three technologies respectively. Their corresponding correlation has been fitted with an algebraic expression having a correlation coefficient of 0.91. The analysis presented in this paper allows the policy-makers to access two important aspects, namely, the energy payback period and the environmental friendliness in terms of two important parameters: the EYR and the emission coefficient. (1 figure, 13 references)

Mathur J, Bansal N K, and Wagner H-J. 2002
Energy Sources 24(1): 19-26

Mechanical Engineering Department, Malaviya Regional Engineering College, Jaipur, India
<jyot1@hotmail.com>

The potential contribution of renewable energy in air pollution abatement in China and India

[313] The potential for the cost effectiveness of renewable energy sources in air pollution abatement has been studied in this paper with respect to China and India. A study of the costs and the environmental impacts of several types of renewables in comparison to fossil fuels has been done for the period 1990–2020 for China and India. The costs of SO_2 emission-control through the switch to renewable energy sources are analysed and compared with the costs of controlling the emissions from fossil fuels, using the RAINS-Asia (Regional Air Pollution Information and Simulation-Asia) model. The study shows that increased use of renewable energy could cut SO_2 emission-control costs in China by 17%–35% and in India by more than two thirds. (4 figures, 5 tables, 16 references)

Boudri J C, Hordijk L, Kroeze C, *et al.* 2002
Energy Policy 30(5): 409-424

Environmental Systems Analysis Group, Wageningen University, Department of Environmental Sciences, Diedenweg 18, 6703 GW Wageningen, The Netherlands
<carolien.kroeze@wimek.cmkw.wau.nl>

Environmental benefits on a life cycle basis of using bagasse-derived ethanol as a gasoline oxygenate in India

[314] The environmental benefits of using bagasse-derived ethanol as a gasoline oxygenate in India, have been presented in this paper. An LCA (life cycle assessment) was conducted to quantify the environmental benefits of using bagasse for ethanol production rather than disposing it through the current practice of open field burning. The LCA results showed lower net values for the ethanol scenario for CO, hydrocarbons, SO_x, NO_x, particulates, CO_2, methane, and fossil energy consumption. Due to the lower greenhouse potential, the CDM (clean development mechanism) or a similar mechanism can be used to help deploy the bioethanol option in India. (4 figures, 7 tables, 32 references)

Kadam K L. 2002
Energy Policy 30(5): 371-384

National Renewable Energy Laboratory, 1617 Cole Boulevard, Golden, Colorado 80401-3393, USA <kiran_kadam@nrel.gov>

Towards planning on a national basis

[315] The electric power system in India has seen phenomenal growth since independence. In the beginning, the power systems were very small and localized. Gradually, state grids came into existence and then came the regional grids. There is a strong motive

to build and operate a national grid by the end of the Eleventh Plan (2011–12), so that the resources located at far off places are utilized optimally and the diversity in demand among different regions brings down the total capacity requirements to meet the demand. The decrease in total capacity requirement results in saving on the part of generating capacity but requires investment in inter-regional transmission lines for transfer of power from one region to another. Studies have been carried out to evaluate the benefits of regional interconnection. A revised demand projection (tentative) of 157 013 MW on an all-India basis (excluding islands) at the end of the Eleventh Plan has been considered for carrying out the studies. An examination of the load curve of regions has indicated inter-regional diversity of 3.5%. With this diversity, the installed capacity required to meet the demand at the end of the Eleventh Plan (2011–12) on an all-India basis is 205 000 MW which is about 7000 MW less compared to the case with simple interconnection among the regions without diversity. This results in substantial savings in terms of capital cost and resources. (1 table, 2 figures)

Gupta V B, Ramar S, and Sharan I. 2001
Vidyut Bharati 24(2): 4-7

Central Electricity Authority, Seva Bhavan,
R K Puram, New Delhi - 110 066, India

Examples and case studies of energy-efficiency projects in India

[316] Energy conservation in utilities has played a vital role in achieving energy efficiency in the industrial, commercial, and residential sectors. It is the heart of all energy-efficiency programmes. Regardless of the type of industry, commercial space, or building, the art and philosophy of energy-saving techniques are common and transferable. This article deals with a few common, innovative, and profitable case studies of energy-saving ideas for utilities and typical specialized equipment for the practicing energy engineers, as executed in India. (5 tables, 19 references)

Dutta S K. 2002
Energy Engineering 99(1): 32-49

Indian Institute of Social Welfare and Business
Management, College Square West,
Kolkata - 700 072, India
<iiswbm@iiswbm.edu>

Direct and indirect energy requirements of households in India

[317] The demand for the energy using services in the household sector in India has been growing at an increasing rate since the early 1980s and is likely to expand rapidly in the coming years too. This paper determines the factors responsible for the growing energy consumption rate by quantitatively analysing the direct and indirect energy requirements of households in India over the years 1983/84 to 1993/94. The results show that total household energy consumption is evenly divided between direct and indirect energy and comprises 75% of the total energy consumption of India. Most of the household energy consumed directly is still non-commercial and the consumption of food is responsible for half of the indirect energy consumption. The main factors responsible for the increased household energy consumption are identified as (1) the growing expenditure per capita, (2) population, and (3) increasing energy intensity in the food and agriculture sectors. (6 figures, 3 tables, 43 references)

Pachauri S and Spreng D. 2002
Energy Policy 30(6): 511-523

Centre for Energy Policy and Economics, Swiss
Federal Institutes of Technology, ETH Zentrum
WEC, CH-8092 Zuerich, Switzerland
<shonali.pachauri@cepe.mavt.ethz.ch>

Policy, planning, prospects and promotion of renewable energy programmes in India during Tenth Five Year Plan (2002–07)

[318] There has been a rapid decrease in the fossil fuel reserves for meeting the energy requirements of India, due to which, the harnessing of renewable energy sources to meet energy require-

Khare D K and Tripathi A K. 2002
IREDA News 13(1): 13-24

Ministry of Non-conventional Energy Sources,
CGO Complex, Lodhi Road,
New Delhi - 110 003, India

ments has gained importance recently. This paper discusses the policy, planning, and prospects of renewable energy programmes in India during the Tenth Five Year Plan (2002–07). A total outlay of 102.9 billion rupees is proposed for renewable energy development in India during Tenth Plan. (6 figures, 4 tables)

Meeting Sri Lanka's future electricity needs

[319] This paper traces the history of the power sector in Sri Lanka and also highlights the principles of the methodical development of power generation in the country. The main state sector agency in electricity generation and distribution is the CEB (Ceylon Electricity Board). The CEB is also entrusted with generation planning and it is empowered to make its decision on the basis of least cost to the national economy. The country faced its most severe power crisis in 1996 and is facing another such crisis today. This paper presents the CEB planning exercise in detail and shows how the plans were developed keeping in view the country's needs at various times. The generating options considered involve both conventional energy sources and renewables, and the selection is based on an analysis using the International Atomic Energy Agency's WASP III simulation model. It is shown that the Sri Lankan power system is in a state of transition from being predominantly hydro-based to being predominantly coal-based within the first decade of this century. The paper concludes that the proof of the effectiveness of the plan will be in its implementation. (2 figures, 3 tables)

Fernando S. 2002
Energy for Sustainable Development 6(1): 14-20

Thermal Complex, Ceylon Electricity Board,
PO Box 4, Kolonnawa, Sri Lanka

Assessing the global energy innovation system: some key issues

[320] Energy technology innovation has played a central role in the advancement of the energy sector. The major challenges facing the energy system – ensuring adequate supply of energy services at low cost while mitigating adverse local and global environmental impacts – will require further innovation (i.e. research, development, demonstration, and deployment) in energy technologies. Yet the understanding of the global energy innovation system is incomplete, with a majority of the analyses focusing on energy research and development in industrialized countries, and within that domain, on funding levels. A much more systematic effort is warranted to assess, and fill, the gaps in understanding of the global energy innovation system and develop appropriate policies for guiding this system to meet future challenges. (28 references)

Sagar A D and Holdren J P. 2002
Energy Policy 30(6): 465-469

Programme in Science, Technology and Public
Policy, Belfer Centre for Science and
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Government, 79 John F Kennedy Street,
Harvard University, Cambridge, M A 02138,
USA <ambuj_sagar@harvard.edu>

Local and community ownership of renewable energy power production: examples of wind turbine projects

[321] Local and community ownership of renewable energy generation, e.g. grid connected wind turbines, can bring widespread benefits to the local community and economy. Ownership may range from 100% of the small projects to minor participation in the larger schemes, but the knowledge and experience of local participation is a significant factor. Barriers that have in the past hindered local and community participation have been identified as lack of fair and easy access to information, specialist knowledge, markets, and finance. This paper details the major advances in community renewable energy projects in the UK over

the past two years that have addressed and overcome these barriers. These include the development of a wholly community-led and community-owned wind turbine project in Mid-Wales and the establishment of a renewable energy investment club to facilitate community investment. (2 figures, 3 tables, 7 references)

Leaney V, Jenkins D, Rowlands A, *et al.* 2002
Wind Engineering 25(4): 215-226

Dulas Ltd, Dyfi Eco Parc, Machynlleth, Powys
SY20 9RA, UK <vickleaney@dulas.org.uk>

Hydrogen futures: toward a sustainable energy system

[322] The use of hydrogen as an energy source is gaining much importance. A number of recent studies suggest that moving to the direct use of hydrogen derived from natural gas and renewable energy will be much cleaner and less expensive. However, less has been done on the part of the governments to encourage the concept and build a hydrogen economy. Research and development, incentives and regulation, and partnership with industry have sparked isolated initiatives. The paper suggests that stronger public policies and educational efforts are needed to accelerate the hydrogen infrastructure development. (10 figures, 5 tables, 112 references)

Dunn S. 2002
International Journal of Hydrogen Energy
27(3): 235-264

Worldwatch Institute, 1176 Massachusetts
Avenue, NW Washington, DC 20036 1904,
USA <sdunn@worldwatch.org>

Risk-reward sharing contracts in the oil industry: the effects of bonus/penalty schemes

[323] In recent years there has been rapid growth in partnering and alliances among oil companies and their contractors. This paper analyses the risk-sharing attributes of some typical types of field development contracts. It highlights the effects of bonus/penalty schemes, which are generally the key elements of these contracts. It was found that these schemes increase total risk for the contractors and have consequences for their cost of capital and optimal risk-bearing arrangements within the industry.
(7 figures, 8 references)

Kemp A G and Stephen L. 1999
Energy Policy 27(2): 111-120

Department of Economics, University of
Aberdeen, Edward Wright Building, Dunbar
Street, Aberdeen AB 24 3QY, UK
<a.g.kemp@abdn.ac.uk.>

Technology policy and renewable energy: public roles in the development of new energy technologies

[324] The renewable energy technologies are not yet cost competitive with the traditional methods of electricity generation. While generation of electricity through wind energy is the closest to commercial viability, further advances in technology are needed for it to become fully practicable. This paper presents a study of the technological and policy history of the development of wind power in the US. The paper concludes that demand-side policies are needed for wind energy technology innovations. The following recommendations as to specific public policies for creating a market for renewable energy are made: (1) provide a consistent and long-term market for wind energy, (2) use information as means of generating demand for wind energy, and (3) government technology choice efforts should be reviewed for path-dependence and be guided by user needs.

Loiter J M and Norberg-Bohm V N. 1999
Energy Policy 27(2): 85-97

Industrial Economics, Inc., 2067
Massachusetts Avenue, Cambridge,
MA 02140, USA

Energy efficiency in the household sector: right diagnosis and wrong therapy

[325] Energy efficiency generates substantial financial savings while simultaneously improving environmental quality. Despite these benefits, developing countries like India are missing out on energy efficiency opportunities and instead concentrating on increased energy production. This paper identifies the efficiency technologies in the household sector in India and details their

benefits to the consumer as well as to the society. It identifies the barriers that prevent the government from achieving its energy efficiency goals, analyses programmes that address these barriers, and explores the creation of an institutional mechanism. The paper concludes that to achieve the goal of efficiency, an institutional mechanism should be evolved through which the existing fragmented and limited-scale markets should be transformed into a greater and more flexible single market. The joint efforts of the stakeholders, financial institutions, researchers, and the government are also required to promote energy efficient technologies. (4 figures, 10 references)

Reddy B S. 2002
IREDA News 13(1): 25-36

Indira Gandhi Institute of Development Research, Goregaon (E), Mumbai - 400 065, India

Cost-effective generation mix for Bangladesh's power supply system

[326] The per capita consumption of electricity is a yardstick in measuring the progress report of a country in a given year. In this respect, Bangladesh, as a developing country, lags far behind. It is yet to reach the standards of exploitation and consumption of electricity already achieved by the developed countries. In order to accelerate the electrification rate and offset the power deficit in the face of growing power demand over supply, a substantially large amount of capacity has to be created. At present many plants are derated due to old age, some have even crossed retirement age and many more have become obsolete, and yet they are kept in operation. Such a situation always advocates for the expansion and overhauling of the existing plant facilities. In this exercise, a linear programming model has been applied to develop an expansion programme based on the optimal generation-mix of various costs attendant therein. The results of the model present the future capacity expansion programme, the optimal operating schedules showing the generation-mix of various power plants at various loads (peak, day-peak, off peak, and base load) throughout the year, and also the optimum generating costs in the future projection periods. (2 figures, 3 tables, 5 references)

Mohiuddin M G and Haque M. 2002
Indian Journal of Power & River Valley Development 52(1 and 2): 19-23

Department of Industrial and Production Engineering, Bangladesh University of Engineering and Technology, Dhaka 1000, Bangladesh

Nuclear power within liberalized electricity markets

[327] Competition between the various methods of generating electricity in liberalized markets means that all power plants must be cost-effective. The price of electricity from nuclear power includes all waste disposal and decommissioning costs, unlike other electricity generating technologies. Most existing nuclear power plants are likely to prosper under electricity liberalization. Many will receive operating life extensions and be able to compete in the electricity market for many years to come. Investment costs are particularly heavy for nuclear plants. Capital expenditure appraisal methodologies mean that such plants suffer financial disadvantages in times of high interest rates. Low and stable fuel costs are the prime advantage of nuclear plants against other sources of generating electricity. There will be significant demand for new generating capacity, both incremental and replacement, in the next 20 years. Under the present conditions, where there is access to a stable and cheap supply of piped gas, nuclear and coal plants find it difficult to compete against gas-fired plants. The nuclear industry is addressing the need for new reactor designs and offering significant capital and

Kidd S W. 2002
Indian Journal of Power & River Valley Development 52(1 and 2): 8-11

operating cost reductions from the previous generation of reactors. This development and the need for carbon abatement on a worldwide basis offers nuclear plants a further economic advantage against alternative technologies. (6 references)

Head of Strategy and Research, World Nuclear Association, Knightsbridge, London, SWIX7LJ, UK

Impact of energy efficiency policy to productive efficiency of electricity distribution industry in the Philippines

[328] This study analyses productive efficiency and simulates the effect of the energy efficiency policy on the productive efficiency of the electricity distribution industry in the Philippines, using data envelopment analysis. The study finds that the main source of technical inefficiency in the distribution utilities is scale inefficiency. Moreover, the study finds that with demand side management electricity savings targets, the technical efficiency of the industry would improve slightly. Also, significant improvement of technical efficiency is found with system loss reduction targets. The paper concludes that the energy efficiency policy, which benefits the overall economy and the whole electricity supply industry, also results in productive efficiency improvement in the distribution sector of the industry. (6 tables, 10 references)

Pacudan R and de Guzman E. 2002
Energy Economics 24(1): 41-54

Energy Program, Asian Institute of Technology, PO Box 4, Klong Luang, Pathumthani 12120, Thailand <romeo@ait.ac.th>

An integrated time-depending feasibility analysis model of wind energy applications in Greece

[329] An integrated time-depending feasibility analysis method is developed in order to improve the reliability of the calculation results concerning the economic behaviour of commercial wind parks in Greece. Under the proposed model, the time dependency of the problem parameters is taken into account. Until now, the vast majority of the feasibility studies neglected the time variation for simplicity reasons. On the contrary, in the present analysis, the evolution with time of the economic variables of the problem is included, taking into account the 20-year data from the local market records. Applying the proposed model to several wind parks erected during 1985–95 in Greece, the significant differences between the results based on time-series data of the main parameters and the corresponding results from their time-mean values are underlined. The proposed model satisfactorily explains the evolution of wind energy applications in Greece during the last 15 years, purely on the basis of economic terms. (17 figures, 17 references)

Kaldellis J K. 2002
Energy Policy 30(4): 267-280

Laboratory of Soft Engineering Applications & Environmental Protection, Mechanical Engineering Department, TEI Piraeus, Pontou 58, Hellinico 16777, Greece <jkald@teipir.gr>

Renewable energy sources project appraisal under uncertainty: the case of wind energy exploitation within a changing energy market environment

[330] A framework for the appraisal of power projects under uncertainty within a competitive market environment is developed in this paper, focusing on the electricity from renewable energy sources. A case study of wind energy project in Greece is presented. The study focuses on (1) the uncertainties within the new deregulated energy market, (2) the evaluation methods including an analysis of the introduced uncertainties after deregulation, and (3) a new approach to project evaluation using real options, as well as comparison of the valuation methodologies within the new environment drawing from the case of Greece. (3 figures, 9 tables, 27 references)

Venetsanos K, Angelopoulou P, and Tsoutsos T. 2002
Energy Policy 30(4): 293-307

Centre for Renewable Energy Sources, 19th Km Marathonos Avenue, GR-19009 Pikermi, Greece <ttsout.cres.gr>

Energy analysis of Saudi Arabia

[331] In this study, an energy analysis has been conducted for Saudi Arabia to evaluate its energy resources in terms of production, consumption, and energy utilization in the main sectors and to provide forecasting models for future projections. It is obvious that Saudi Arabia is not only one of the world's major energy producers but also one of the world's largest energy consumers. The high rate of growth of Saudi Arabia's population and hence the high-energy utilization in various sectors are the two major reasons for the high-energy consumption in Saudi Arabia. (11 figures, 1 table, 9 references)

Dincer I and Al-Rashed B. 2002
International Journal of Energy Research
26(3): 263-278

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Box 127, Dhahran 31261, Saudi Arabia
<idincer@kfupm.edu.sa>

Regional industrial ecology: examples from regional economic systems of forest industry and energy supply in Finland

[332 Industrial ecology promotes the development of industrial systems based on the recycling of matter and cascading of energy through cooperation. In this paper, the local/regional industrial ecosystem approach is reflected in two examples from Finland. The local forest industry system is based on renewable resources, waste materials and energy utilization between forestry companies, a saw mill, a pulp mill, and a forest industry power plant. Waste energy from electricity production is used for production of heat and process steam. Regional city energy supply systems in Finland are also to a large extent arranged around power plants that utilize waste energy. The potential of combining the forest industry system with the energy supply systems of cities is considered and the conditions for success in the Finnish case are also discussed in this paper. (4 figures, 31 references)

Korhonen J. 2001
Journal of Environmental Management 63(4):
367-375

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Joensuu, PO Box 111, 80101 Joensuu,
Finland <Jouni.Korhonen@joensuu.fi>

Agro-residue based renewable energy technologies for rural development

[333] Energy consumption in the rural sector of India, particularly in the form of petroleum-based fuels, has increased manifold during the last 40 years or so. Fast depleting stocks of fossil fuels and steep increases in their prices may lead to an energy crisis in the not-too-distant future. Such a crisis will have a serious effect on all economic and domestic activities, particularly in the vast rural areas. The large quantities of crop residues resulting from crop cultivation are a promising source of energy supply for production, processing, and domestic activities in rural India. The available crop residues are either being used inefficiently or burnt in the open to clear the fields for subsequent crop cultivation. A crop residue-based decentralized energy/electricity supply system will also help establish agro-based productive activities in the rural areas and hence create large-scale employment for rural youth. Important biomass-based energy technologies developed under the All India Coordinated Research Project on Renewable Sources of Energy for Agriculture and Agro-based Industries and having potential for wider adaptation are described in this paper. (3 tables, 6 references)

Shyam M. 2002
Energy for Sustainable Development 6(2):
37-42

Central Institute of Agricultural Engineering,
Nabi Bagh, Berasia Road, Bhopal - 462 038,
India <mshyam@ciae.mp.nic.in>

Analysing industrial energy use: a case study of the Swedish forest industry

[334] An analytical method that can be used to incorporate development in industrial sub-sectors in national energy systems modelling analysis has been presented in this paper. The method is

illustrated by a case study of the Swedish forest industry. The case study consists of a detailed analysis of the industrial sub-sector scenario of the Swedish forest industry and an analysis of usefulness of incorporating such a detailed treatment of the industry in energy system modelling analysis. The results show that the forest industry's degree of self-sufficiency with regard to both electricity and fuel increases strongly under both the scenarios. A more detailed industrial sub-sector analysis can be incorporated in energy systems modelling analysis through soft linking of forest industry results and a Nordic energy system model. (8 figures, 5 tables, 27 references)

Nystrom I and Cornland D W. 2002
International Journal of Energy Research
26(5): 431-453

Energy Systems Technology Division, Chalmers
University of Technology, S-412 96 Göteborg,
Sweden <inni@entek.chalmers.se>

Photovoltaic module quality in the Kenyan solar home systems market

[335] This paper analyses market failure associated with PV module quality in the Kenyan SHS market and develops strategies to address the problem. The principal conclusion is that domestic product testing with public disclosure represents an inexpensive low-risk strategy, but it may prove inadequate. Mandatory product quality standards based on international testing regimes (e.g. IEC standards), augmented with a basic domestic testing option, would provide stronger assurance, but the risk associated with this intervention suggests caution. An emerging multilateral SHS market support effort (PVMTI) should ensure quality for the credit-based sales it promotes in Kenya. However, the long-term impact of this approach is not yet clear and it is unlikely to address the quality problems associated with the existing unsubsidized sales-based markets for SHSs. Finally, fee-for-service models would decisively address quality problems, but launching this model in the Kenyan market would likely require large subsidies. (4 figures, 3 tables, 39 references)

Duke R D, Jacobson A, and Kammen D M.
2002
Energy Policy 30(6): 477-499

Energy and Resources Groups, University of
California, Berkeley, CA 94720-3050, USA
<dkammen@socrates.berkeley.edu>

Green electricity in the market place: the policy challenge

[336] The liberalization of the electricity markets and steadily growing focus on sustainable energy production are the two factors that have dramatically changed the role of public policy with respect to energy. This paper aims at exploring the implications of these new market conditions for the policy means and mechanisms to enhance the market penetration of renewables. The need for policy intervention to help producers and consumers move out of technological trajectories favouring non-renewable electricity and to support the diffusion of renewable energy in the market has been discussed. The paper concludes that the policy approaches currently employed to foster the market share of renewables based electricity are insufficient. The author suggests a reflexive policy approach to initiate and support a reorientation towards green electricity, emphasizing the need for learning and communication among societal actors. (1 figure, 1 table, 27 references)

Fuchs D A and Arentsen M J. 2002
Energy Policy 30(6): 525-538

Faculty of International Relations, Ludwig-
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80538 Munich, Germany
<doris.fuchs@lrz.uni-muenchen.de>

Transmission capacity and market power: the effect on a dominant generation firm

[337] With the restructuring of the electricity industry, the importance of transmission in promoting an efficient dispatch of generation is becoming more evident. This paper analyses the market power of a dominant generation firm and shows that added

transmission can reduce the market power of the firm and reduce the price of electricity generation. Application of the research to the Colorado electricity industry showed that the dominant firm can strategically congest transmission into the region to receive a maximum price of 54.9% of the time. When it does not get the maximum price, the dominant firm can receive a mark-up of 11.6%, on average, over the competitive price. The threat of entry across an enhanced transmission grid can increase competition and limit market power in the Colorado electricity industry. (4 figures, 1 table, 22 references)

Quick D M and Carey J M. 2002
Energy Policy 30(8): 699-708

Division of Economics and Business, Colorado School of Mines, Golden, CO 80401-1887, USA <daquick44@cox.net>

Demand for commercial energy in the state of Kerala, India: an econometric analysis with medium-range projections

[338] The consumption of commercial energy has been rapidly increasing in the state of Kerala, aggravating the present energy crisis. In this study, econometric models have been developed, which explain the demand of three major forms of commercial energy – electricity, petroleum products, and coal – in terms of major socio-economic determinants. The developed models have been refined and validated to ensure consistency. The models have been employed for forecasting the future energy requirement till 2020. The requirements of future energy as well as the structure and pattern of consumption have been examined. The policy implications of the forecast results have been critically analysed. The results identify the basis on which energy planning can be carried out and emphasize the need for evolving effective strategies. (2 figures, 9 tables, 18 references)

Sharma D P, Nair P S C, and Balasubramanian R. 2002
Energy Policy 30(9): 781-791

CED, Department of Space, Bangalore - 560 394, Karnataka, India <sharma_dp@satyam.net.in>

Policy instruments fostering wind energy projects—a multi-perspective evaluation approach

[339] The policy instruments developed so far, which aim at fostering the use of renewable energy carriers in power generation, have neglected the interests and requirements of important stakeholder groups. This paper proposes a new approach to the design of policy instruments while taking into account the different interests of all the relevant stakeholder groups in the three fields: renewable energy business, policy making, and conventional power business. (3 figures, 1 table, 25 references)

Enzensberger N, Wietschel M, and Rentz O. 2002
Energy Policy 30(9): 793-801

Universität Karlsruhe, Institute of Industrial Production, Hertzstr 16, 76187 Karlsruhe, Germany <norbert.enzensberger@wiwi.uni-karlsruhe.de>

Direct energy conversion

Assessment of molten carbonate fuel cell models and integration with gas and system cycles

[340] This paper investigates the performance of MCFCs (molten carbonate fuel cells) with external sensible heat reformers and GT/ST (gas turbine/steam turbine) combined cycles. The analysis of these MCFC-GT/ST combined cycles has been carried out using the Thermo Economic Modular Program. The code has been verified through the use of a detailed MCFC model and of the data available for an existing MCFC unit. The thermodynamic and exergy analysis of a number of MCFC combined cycles is presented and discussed. The results show that MCFC combined cycles could be very attractive, although reliability and durability comparable with conventional power and low cost (essential to market entry) are still to be proved. From

Massardo A F and Bosio B. 2002
Journal of Engineering for Gas Turbines and Power 124(1): 103-109

this point of view the thermoeconomic investigation of such systems, also taking into account the environmental impact (environmental cost internalization), should be the next step of this activity. (14 figures, 1 table, 13 references)

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<massardo@unige.it>

An assessment of alkaline fuel cell technology

[341] The research and development in AFC (alkaline fuel cell) technology has become stagnant during the past decade for no obvious technical or economic reasons. In this paper, a review of AFC technology has been presented to assess its potential. Publications during the past 25 years have been reviewed. AFCs have been shown to provide high power densities and achieve long lifetimes in certain applications, and also appear to compete favourably with the ambient air PEMFCs (proton exchange membrane fuel cells). Issues surrounding the sensitivity of the AFC to CO_2 in the oxidant stream are reviewed and potential solutions discussed. A rough cost comparison between the ambient air AFCs and PEMFCs is presented. The results suggest that more R&D is required to develop the technology into successful market offerings. (2 figures, 18 tables, 75 references)

McLean G F, Niet T, Prince-Richard S, Djilali N. 2002
International Journal of Hydrogen Energy
27(5): 507-526

University of Victoria, PO Box 3055, STN CSC
Victoria, BC Canada V8W 3P6, Canada
<gmclean@me.uvic.ca>

Thermodynamic and economic analysis of a steam reformer–solid oxide fuel cell system fed by natural gas and ethanol

[342] In the present study, ethanol and methane are compared as candidate fuels for the SOFCs (solid oxide fuel cells). The thermodynamic analysis of both alternatives was undertaken considering that an SOFC stack operates by being fed with the equilibrium products of the steam reforming of each raw fuel. The comparison was made at atmospheric total pressure assuming low reforming factors (steam/fuel feed ratios) and SOFC operation in the temperature range of 800–1200 K. All operation conditions have been selected so that the carbon deposition in the SOFC anode is thermodynamically impossible. Results were obtained in terms of the maximum theoretical electromotive force and the thermodynamic efficiency of total energy conversion. It was found that both fuels exhibit similar thermodynamic behaviour when fed in an SOFC stack. Some qualitative advantages with respect to ethanol are also discussed. (3 figures, 2 tables, 14 references)

Douvartzides S and Tsiakaras P. 2002
Energy Sources 24(4): 365-373

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Mechanical and Industrial Engineering, Pedion
Areos, Volos, Greece <tsiak@mie.vth.gr>

A solid oxide fuel cell with a novel geometry that eliminates the need for preparing a thin electrolyte film

[343] A solid oxide fuel cell design based on a configuration of two electrodes on the same surface of the electrolyte in a flowing mixture of different hydrocarbons and air between 500–600 °C has been proposed in this paper. The ohmic resistance can be reduced without using a thin electrolyte film due to a significantly enhanced performance by the approach of the two electrodes to each other on the smooth electrolyte surface. The fuel cell performance, especially at reduced temperatures, is further improved by using a more reactive hydrocarbon fuel and a more catalytically active anode. The resulting power density reaches 122 mW/cm^2 using a 2-mm thick electrolyte at 500 °C. (10 figures, 2 tables, 18 references)

Hibino T, Hashimoto A, Suzuki M, *et al.* 2002
Journal of The Electrochemical Society
149(2): A195-A200

National Institute of Advanced Industrial
Science and Technology, Nagoya 462-8510,
Japan <takashi.hibino@aist.go.jp>

Characteristics of electrodes materials and their lifetime modeling for AMTEC

[344] AMTEC (the alkali metal thermal to electric converters) has problems associated with long-term and continuous use. The power output of the device is yet to perform consistently with time. The electrode is one of the components, which contribute to the degradation of the power output of AMTEC. In this paper, three electrodes made of RhW, Rh_2W and TiN have been examined for degrading effects on AMTEC's power output. The results show that RhW is the best working electrode, as it is least affected by grain growth. Rh_2W is found to be the other better electrode compared to the TiN electrode. (5 figures, 4 tables, 13 references)

Lodhi M A K and Chowdhury M S. 2002
Journal of Power Sources 103(1): 18-24

Department of Physics, Texas Tech University,
Lubbock, TX 79409, USA
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Energy conservation, consumption, and utilization

Comparative energy efficiency studies for the conventional and model coal-fired round down draught ceramic kiln

[345] The environment has become the prime issue for the last few years. The steep rise of the price of energy process and the environmentalists' demand on maintaining a cleaner environment is forcing the small-scale industries to close their units as they are becoming unable to compromise both the fuel cost and the high installation and maintenance costs of the pollution control equipment. They are looking for alternatives, which are based on a clean-technology. To meet their demand, an energy-efficient coal-fired round down draught kiln has been designed, developed, erected, and commissioned successfully by the working group at the Centre for Ceramic Rural Development at Panchmura in Bankura. The kiln is clean-technology based, energy efficient, and low polluting with simple operating procedures and would help the small-scale industries take up their future action plans. (4 figures, 4 tables, 16 references)

Dasgupta S, Basu A K, Chakraborty R, *et al.* 2002
Journal of Institution of Engineers (India)-Environmental Engineering 82(March): 42-47

Central Glass and Ceramic Research Institute,
Kolkata - 700 032, India

Microturbine/fuel-cell coupling for high-efficiency electrical-power generation

[346] Microturbines and fuel cells are currently attracting a lot of attention to meet future user-needs in the distributed generation market. This paper addresses a preliminary analysis of a representative state-of-the-art 50-kW microturbine coupled with a high-temperature SOFC. The technologies of the two elements of such a hybrid power plant are in a different state of readiness. The microturbine is an early stage of pre-production and the SOFC is still in the development phase. It is premature to propose an optimum solution. Based on today's technology, the hybrid plant, using natural gas fuel, would have a power output of about 389 kW and an efficiency of 60%. If waste heat is used, the overall fuel utilization efficiency would be about 80%. The major features, parameters, and performance of the microturbine and the SOFC are discussed in this paper. The compatibility of the two systems is addressed, while the areas of technical concern and the mismatching issues are identified and discussed. Fully understanding these, and identifying solutions, is the key to the future establishment of an optimum overall system. The author suggests that a high performance and cost-effective hybrid plant, with high reliability, will be ready for commercial service by the middle of the first decade of the 21st

Massardo A F, McDonald C F, and Korakianitis T. 2002
Transactions of the ASME 124(1): 110-116

century. While several microturbines can be packaged to give an increased level of power, this can perhaps be more effectively accomplished by coupling just a single gas turbine module with an SOFC.

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Some findings on heat energy audit for sugar factory

[347]

Jadhav M G. 2002
Cooperative Sugar 33(8): 635-642

Department of Mechanical Engineering, Walchand Institute of Technology, Ashok Chowk, Solapur, Maharashtra - 413 006, India

The sugar industry in the country is under great pressure to reduce production costs. This has become a top priority in the context of increasing liberalization and an opén economy. Increases in efficiency, productivity, conservation of energy, and consumables are key areas. The present paper is devoted to the auditing of heat energy and the determination of recoverable waste heat potential, so that further steps for reducing and/or recovery of waste heat can be exercised. This will help to a great extent in overcoming the present uncomfortable situation in the world market and in relieving the economic stress on the home front. (2 figures, 9 references)

Recycling of after-extraction-residues and fly ash through composting for amelioration of alkaline soil

[348]

Kumbhar P P, Patil Y M, Chavan C D, *et al.* 2002
Journal of Scientific & Industrial Research 61(4): 286-288

School of Chemical Sciences, North Maharashtra University, Jalgaon - 425 001, India <kumbharpp@rediffmail.com>

Indiscriminate use of chemical fertilizers and pesticides has transformed large areas of agriculturally fertile soils into alkaline soils. This paper discusses the feasibility of using AER (after-extraction-residues) and fly ash for amelioration of alkaline soils. The paper suggests that if AER and fly ash are added to the soil after preparing their composts in varying proportions, instead of being directly added to the soil, this will help improve soil texture, fertility, and thus, the yield of agricultural produce. (4 tables, 8 references)

Cogeneration: efficiencies and economics

[349]

Fridman M O. 2002
Cogeneration and Competitive Power Journal 17(1): 71-78

1100 Rutland Rd, Unit 7, Newport Beach, CA 92660, USA <mfridman@sirspeedy.com>

The magnitude of cogeneration plant efficiency cannot, by itself, prove the plant's feasibility. The most reliable way to determine the feasibility of a cogeneration plant is to compare its performance with the conventional scheme of generating electric power by a utility and obtaining thermal energy (steam or hot water) from a boiler. For such a purpose, and for comparison of different types of prime-movers (steam turbines, gas turbines, combined cycles, and reciprocating engines), the most convenient way is to convert the electric power output into thermal units, and to base the comparison on higher heat values.

Performance of a low-energy consumption house experiencing a Mediterranean climate

[350]

Tahat M A, Al-Hinai H, and Probert S D. 2002
Applied Energy 71(1): 1-13

More than 30% of the purchased energy consumed in the Western world is used for heating, and/or cooling of domestic and commercial buildings. Thus, the improvement of building designs in order to provide comfortable living conditions with far lower purchased energy demands, is desirable worldwide. In this paper, a low energy consumption house has been designed and its behaviour simulated using a thermal analysis computer system. The conclusions from the simulation analysis were implemented when constructing a four-bedroom house in Sarih, Jordan (32.6 °N, 35.9 °E, and 616 metres above sea level). The thermal performance and resulting experimental data corroborated the simulation predictions. The actual performance achieved was found to be superior to that of a typically nominal and similar-sized house commonly found in Jordan. (12 figures, 2 references)

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Chemi-refiner mechanical pulping of flax shives: refining energy and fiber properties

[351] Oil-seed flax shive has been promoted as a raw material for low-end paper making because of its overall cost benefit over hardwood and groundwood pulp and the increasing demand for low-cost pulp in rigid packaging applications. A refiner mechanical pulp from oil-seed shives has been made by using a 300-mm Sprout-Bauer pilot refiner. The factors controlled during refining were: consistency, multi-pass refining, temperature, spacing between the plates, and polyol-anhydride reactant concentration. Based on the results in this study it is apparent that unmodified shives develop low mechanical strength, shorter fibres, and large amount of fines. Chemical modification of shives with a pre-reacted mixture of polyol-anhydride reduces refining—energy consumption improves strength performance but decreases scattering coefficient. The results of the investigation suggest that chemically modified refiner pulp from shives cannot be used for high-grade paper manufacture but it can be used as a low-cost filler for low-end applications in packaging or low-performance decorative papers. (9 figures, 5 tables, 9 references)

Sain M, Fortier D, and Lampron E. 2002
Bioresource Technology 81(3): 193-200

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Pulp and Paper Research Centre, University of
New Brunswick, Fredericton, NB, Canada E3B
6C2, Canada <m.sain@utoronto.ca>

Purchased-energy consumption in Jordan's commercial and public service sector

[352] In 1988, the energy consumed in the commercial and public service sectors accounted for about 8.8% of the final purchased-energy consumption in Jordan. In addition to electricity, the main fuels used in these sectors are diesel, LPG, and kerosene. These forms of energy are primarily used for lighting, air conditioning, and running appliances. Many opportunities exist to improve energy efficiencies in buildings, with a net saving ratio of 10%–15%. These include primarily, but are not limited to, improving the designs and choice of boilers, air conditioning and ventilation systems, temperature controls, thermal insulation, and lighting. The advantages of such improvements include reducing the burden on the economy through raising efficiency, creating more jobs for engineers and the skilled workforce, and decreasing emissions to the environment. However, there is an urgent need to conduct detailed energy audits for various types and usages of existing commercial buildings in Jordan, in order to identify the best energy-effectiveness enhancement measures.

Jaber J O and Probert S D. 2002
Applied Energy 71(1): 31-43

Department of Mechanical Engineering, The
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<jojaber@hu.edu.jo>

Removal of organic matter from dairy industry waste water using low-cost adsorbents

[353] The present study envisages the use of cost-effective adsorbents such as fly ash, bagasse, wheat straw dust, sawdust, and coconut coir for the reduction of the TDS (total dissolved solids) from dairy industry effluent waste water. PAC (powdered activated carbon) was also used and the results were compared. The raw sorbent materials were treated for delignification prior to use. The effects of pH, contact time, adsorbent dose, initial concentration of adsorbate (TDS), and adsorbent particle size were also evaluated. The PAC was effective at pH 4.0, whereas the

other five low-cost adsorbents were effective in the removal of the TDS at 6.0 and 8.0 increases in contact time, adsorbent dose, low adsorbate concentration and smaller particle sizes. Sorption data have been correlated with both the Langmuir and the Freundlich adsorption isotherm models. The Freundlich static isotherm model is found applicable to all the six adsorbents for removing TDS from the dairy waste water. The order of selectivity is PAC, bagasse, fly ash, sawdust, wheat straw, coconut coir for the removal of TDS at optimum conditions. (6 figures, 3 tables, 8 references)

Rao M and Bhole A G. 2002
Indian Chemical Engineer 44(1): 25-28

Civil Engineering Department, College of
Engineering, Badnera - 444 701, India

Development of a new drying correlation for practical applications

[354] This paper deals with the development of a new Biot number—drying coefficient correlation. The developed correlation is used to determine the moisture transfer parameters in terms of the moisture diffusivity and moisture transfer coefficient involved in the solids drying process. In the development of the correlation, a large number of experimental data, from various sources in the literature, are employed. In order to verify the validity of the present correlation, three sets of experimental moisture content variations for three different products such as potato, apple, and yam are compared with the moisture profiles calculated using the correlation results and a good agreement is found. Thus, it is believed that the developed correlation will be helpful to design engineers and workers in the drying industries, for calculating the parameters affecting the drying process in a simple and accurate manner and for optimizing the process. (4 figures, 1 table, 10 references)

Dincer I, Hussain M M, Yilbas B S, Sahin A Z. 2002
International Journal of Energy Research 26(3): 245-251

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Box 127, Dhahran 31261, Saudi Arabia
<idincer@kfupm.edu.sa>

Bacteria for improvement of oil recovery: a laboratory study

[355] In the MEOR (microbial enhanced oil recovery) technique, microorganisms and/or their products (gases, chemicals, etc.) are used for the enhancement of oil recovery. In the present study, the MEOR technique is tested for Garzan (26 ° API) crude oil, produced from South-east Turkey. This work consists of shut-in pressure tests and microbial water flooding experiments. In shut-in pressure tests, the oil is placed in a stainless steel cell and a certain amount of microbial solution (*Clostridium acetobutylicum*) is introduced. During the soaking period, the pressure increase is monitored. The results of the measurements carried out after this stage show that gas (mainly CO_2) production by the bacteria decreases the oil viscosity effectively. In microbial flooding experiments, an unconsolidated and preflooded reservoir model is subjected to microbial treatment and then flooded with water under varying conditions. The bacteria used in these experiments were *Clostridium acetobutylicum* and mixed soil bacteria. When compared with a conventional water flood, the results of the microbial runs showed that the residual oil recovery increased more than 100% and the pH of the medium decreased. (4 figures, 2 tables, 16 references)

Behlülgil K and Mehmetoğlu M T. 2002
Energy Sources 24(5): 413-421

Petroleum and Natural Gas Engineering
Department, Middle East Technical University,
06531 Ankara, Turkey

Use of CFD simulation as a design tool for biomass stoves

[356] The design of biomass stoves has relied mostly on empirical information and trial-and-error experiments backed up by simple thermodynamic and heat-transfer calculations. Quite fre-

quently, the details of fluid flow inside the biomass stove, which is caused by buoyancy due to the high temperature prevailing in the combustion region, have been ignored and the correlations of the heat transfer based on forced flow have been used in the heat transfer analysis of stoves. This paper presents an approach in which detailed CFD (computational fluid dynamics) simulations of the flow, heat transfer, pyrolysis, and combustion in the configuration of a simple sawdust stove are used to evolve simple algebraic equations that describe individual phenomena. Such equations are needed for performance analysis and prediction, and could also be used for the optimization of stove-geometry for performance. The paper describes the development of the building-blocks of the detailed simulation model and its use in the derivation of simple model equations relating design and performance parameters. (5 figures, 13 references)

Ravi M R, Kohli S, and Ray A. 2002
Energy for Sustainable Development 6(2): 20-27

Department of Mechanical Engineering, Indian Institute of Technology Delhi, Hauz Khas, New Delhi - 110 016, India <ravimr@mech.iitd.ernet.in>

Community participation in household energy programmes: a case study from India

[357] The processes of design, development, promotion, manufacture, and dissemination of the biomass cook-stoves in the village of Chibau Khera near Lucknow in India has been discussed in this paper. The project was characterized by extensive community participation and considerable activity in the village. The value of participatory techniques is illustrated in this paper using examples drawn from the case study. Community involvement in the design, testing, and manufacture of the stove is presented as a way of helping ensure the effectiveness, suitability, and sustainability of a stove programme. In the same way, the importance of field workers discussing issues, listening to stakeholders, observing cooking activities, and being open to change is emphasized. Integrated approaches to household energy problems are also discussed. The paper concludes that gaining a detailed understanding of beneficiaries – including their needs, attitudes, resources, and environment – is necessary for the design and implementation of effective and sustainable energy solutions. (4 figures, 21 references)

Rouse J. 2002
Energy for Sustainable Development 6(2): 28-36

Water, Engineering, and Development Centre, Loughborough University, Leicestershire LE11 3TU, UK <J.R.Rouse@lboro.ac.uk>

Advanced automotive propulsion systems

The effects of diesel-ethanol blends on diesel engine performance

[358] The performance of a variable compression ratio engine operating on ethanol-diesel fuel blends has been evaluated experimentally in this paper. The aim was to determine the optimum percentage of ethanol and the compression ratio of the engine that give the best performance and efficiency at the same time. The engine was operated with ethanol-diesel fuel blends having 2%, 4%, and 6% ethanol on a volume basis as well as on diesel fuel alone. The experiments were performed for the compression ratios of 19, 21, and 23. Experimental results indicate that the addition of 4% ethanol to diesel fuel increases the power output and the efficiency of the engine while it decreases specific-fuel consumption for various compression ratios. The best efficiency was attained at the compression ratio of 21 with an increment ratio over 3.5%. (5 figures, 3 tables, 15 references)

Bilgin A, Durgun O, and ªahin Z. 2002
Energy Sources 24(5): 431-440

Mechanical Engineering Department, Karadeniz Technical University, 61080 Trabzon, Turkey <bilgin@ktu.edu.tr>

Dynamic performance assessment of an isolated wind-diesel power system with superconducting magnetic energy storage unit under turbulent wind and load disturbances

[359]

Mufti M D, Balasubramanian R, and Tripathy S C. 2002
International Journal of Energy Research
26(3): 185-201

Centre for Energy Systems, Indian Institute of Technology Delhi, Hauz Khas,
New Delhi - 110 016, India
<rbmanian@ces.iitd.ernet.in>

One of the major problems with the stand-alone wind-diesel power systems is that the overall system inertia is relatively small, and consequently, they are very sensitive to load variations. The paper presents the modelling and control aspects of an isolated wind-diesel system equipped with an SMES (superconducting magnetic energy storage) unit, which is incorporated into the supply quality improvement of the wind-diesel system under disturbances. A multi-input-output STR (self-tuning regulator) is proposed for coordinated active and reactive power control of the SMES unit. The parameters of the STR are adjusted for quality improvement of the power supply under turbulent wind. The simulation results show the positive impact of the proposed scheme on the quality of the power supply under turbulent wind and load disturbances. (11 figures, 8 references)

Internet resources

Information Service for Energy Efficiency

www.emcisee.com

The Information Service for Energy Efficiency is set up jointly by the Energy Management Centre and the Federation of Indian Chambers of Commerce and Industry. The site provides information on products, services, and case studies in the field of energy efficiency. It also contains energy audit manuals, best practice guides, technology options, government policies and notifications, profiles of energy efficient companies, and energy efficiency publication index.

Oil and Gas International

www.oilandgasinternational.com

Oil and Gas International, is the world's leading online source of upstream petroleum industry news, information, and analysis. It provides industry news updates several times a day and incisive feature articles written by seasoned petroleum journalists around the world and a team of experts across the globe. The site also provides exclusive contents of particular interest to the upstream industry, technology reports, world industry news, drilling and completion, development and production, etc.

Calcutta Electricity Supply Corporation

www.cescltd.com

The CESC Ltd (Calcutta Electricity Supply Corporation Limited) is over a 100-year-old flagship company of the RPG Enterprises, which provides electricity to the city of Kolkata in India. The web site offers value-added services including a summary of the customer's current bill, electricity consumption patterns in the previous 12 months, complaints registration, and safety guidelines. The web site also gives information on fundamentals of electricity including generation, transmission, power saving and safety guidelines. It also has links to several state and central government power related organizations.

IBC Global Conferences

http://www.ibcenergy.com/

IBC is an international organization, organizing conferences and events in the field of renewable energy, oil and gas, utilities, power and nuclear energy, and energy finance. The web site provides a list of the conferences held and the forthcoming conferences, conference papers, industry links, etc.

Electric Power Information Resource

http://www.energycentral.com/

Energy Central is a hub on the Internet for electric power professionals searching for information, products, and services related to the energy industry. By teaming up with companies that service the energy industry, Energy Central provides a broad base of information products – news, directories, events, databases, books, periodicals, reports – all focused on a single industry and all accessible from a single site.

Energy Sector Management Assistance Programme (ESMAP)

www.worldbank.org/esmap

The (ESMAP) Energy Sector Management Assistance Programme is a global technical assistance programme sponsored by the World Bank and the United Nations Development Programme. ESMAP focuses on the role of energy in poverty alleviation and economic development, improving the living conditions while preserving the environment in developing countries and economies in transition. The web site provides information about its activities, projects and publications, partners, and energy news.

Fuel Property Database

www.ott.doe.gov/fuelprops

The US Department of Energy's Office of Advanced Automotive Technologies and the Office of Heavy Vehicle Technologies are jointly sponsoring research efforts to develop and evaluate advanced petroleum-based fuels. This web site provides key data on advanced compression ignition fuels. The database includes data on various physical, chemical, operational, environmental, safety, and health properties. The data results are from tests conducted according to standard test methods. The web site includes the source and test methods for each fuel data set.

Energy Information Administration

http://www.eia.doe.gov/

The Energy Information Administration is a statistical agency of the US Department of Energy. The web site provides data on energy statistics of the world. The data can be searched by geography, fuel, energy sectors, and price. The web site also provides information on energy news and events, publications, energy links etc.

Well Engineering Information Exchange

www.petroweb.co.uk

The web site provides an independent knowledge exchange service to the oil and gas industry, focusing on the entire well operations cycle, with the aim to facilitate learning and experience exchange across the industry. Companies subscribing to this site will be able to exchange information related to equipment, procedures and operations. Petroweb clients are oil companies, service providers, drilling contractors, equipment manufacturers, and legislative authorities.

Renewable Energy

http://www.indiasolar.com/

The aim of this web site is to promote, encourage, motivate, educate, and create awareness about the use of renewable energy. It provides information about the status of renewable energy development and related businesses in India. Lists of energy development agencies, manufacturers of solar water heaters, solar cookers, biomass gasifiers, and biomass research institutes in India are also provided. The web site also provides basic information on the components and types of solar water heaters currently available and the economic and environmental benefits of owning a system. It also has links to renewable energy institutes all over the world.

Council of Energy Efficiency Companies of India

http://www.ase.org/ceeci The Council's mission is to promote energy efficiency policies, programmes, and technologies to create jobs and foster economic growth and environmental improvement throughout India. The web site has a searchable energy business directory which provides information on energy efficient companies in India. The web site also provides information on energy efficiency seminars in India.

Bioenergy Information Network

http://bioenergy.ornl.gov/ This web site of the National Biomass Coordination Office of the US Department of Energy gives information about its research and development activities, biomass energy systems, bio-energy feedstock development, and biofuels programme. The web site is a gateway to information about fast growing trees, grasses, and residues for fuels and power. The web site also provides access to news, publications, databases, and links to related web sites.

Hydrogen Fuel Information Hub

http://www.hydrogenus.com/ The web site of National Hydrogen Association, US, provides information on hydrogen fuels and fuel cells. It provides access to news, events, publications, newsletters, etc. It also provides basic information on hydrogen and safety issues.

Mailing lists

Sustainable energy mailing list

The Digestion mailing list provides a forum for the discussion of anaerobic digestion as a sustainable energy resource. The topics covered include the cost effectiveness of anaerobic digestion, markets for biogas and other co-products, advanced technologies for biogas utilization, environmental benefits, and institutional barriers. To subscribe, send an e-mail to <digestion-subscribe@crest.org> and include the word 'subscribe' in the subject area of the e-mail program.

Energy-efficiency mailing list

Energy-efficiency mailing list provides latest and up-to-date information on energy efficiency. To subscribe, send an e-mail to <majordomo@qube.scottishborders.com> with the command 'subscribe seeo' in the text of the message.

Alternative energy mailing list

This list is intended to provide a forum to discuss the current state of the art and future direction of alternative energy sources that are renewable and sustainable. To subscribe to this list, send an e-mail to <listserv@sjsuvm1.sjsu.edu>. Leave the subject line blank and in the body of the message write 'subscribe AE [Your Name]' (e.g. subscribe AE jane).

Occasional publications

From standards, patents, newsletters, government documents and notifications, annual reports, etc.

Patents

Solar refrigeration and heating system usable with alternative heat sources

Patent number US 6,389,830
Invented by E W Bottum Sr and E W Bottum Jr (Brighton, MI, USA)
Filed by Refrigeration Research, Inc. (Brighton, MI, USA) on 23 May 2001
Granted on 21 May 2002
[Source: www.uspto.gov]

An apparatus for heating and cooling includes a solar collector for transferring heat energy from incident solar rays to a liquid refrigerant material thereby changing a first portion to a gaseous state. An eductor-venturi reduces the pressure of the gaseous refrigerant material and a condenser removes the heat energy thereby changing the refrigerant material back to the liquid state. A heat exchanger associated with the condenser receives the heat energy removed from the refrigerant material. A float evaporator mounted in a cold chamber transfers heat energy from the atmosphere to the liquid refrigerant material thereby changing a second portion to the gaseous state and cooling the cold chamber atmosphere. A float-actuated valve connected to the float evaporator is responsive to a level of the liquid refrigerant material in the evaporator for regulating a flow of the liquid refrigerant material into the evaporator.

Solar power charging system

Patent number US 6,429, 621
Invented by Satoshi Arai (Tokyo, Japan)
Filed by NEC Corporation (Tokyo, Japan) on 28 December 2001
Granted on 6 August 2002
[Source: www.uspto.gov]

A solar power charging system comprising: a voltage converter for converting a voltage level of all original voltage generated by a solar battery into generate a charging voltage and for charging a capacitor by the charging voltage and a duty ratio control circuit electrically coupled to the voltage converter for supplying a driving clock to the voltage converter for allowing the voltage converter to operate based on the driving clock, wherein the duty ratio control circuit adjusts a duty ratio of the driving clock based on a maximum charge power, which depends on the original voltage generated by the solar battery.

Method of growing a silicon crystal in liquid phase and method of producing solar cells

Patent number US 6,429, 035
Invented by Katsumi Nakagawa (Atsugi, Japan), Shoji Nishida (Hiratsuka, Japan), Noritaka Ukiyo (Atsugi, Japan), Masaaki Iwane (Atsugi, Japan)
Filed by Canon Kabushiki Kaisha (Tokyo, Japan) on 24 November 1998
Granted on 6 August 2002
[Source: www.uspto.gov]

A method of growing single crystal silicon in a liquid phase comprises preparing a melt by dissolving a solid of silicon containing boron, aluminum, phosphorus, or arsenic at a predetermined concentration into indium melted in a carbon boat or a quartz crucible, supersaturating the melt, and submerging a substrate into the melt, thereby growing a silicon crystal containing a dopant element. This method can provide a method of growing a thin film of crystalline silicon having a high crystallinity and a dopant concentration favorably controlled, thereby serving for mass production of inexpensive solar cells which have high performance as well as image displays which have high contrast and are free from colour un-uniformity.

Standards

Standard Test Method for Determination of Sulphur Compounds in Natural Gas and Gaseous Fuels by Gas Chromatography and Chemiluminescence

ASTM International (formerly American Society for Testing and Materials), West Conshohocken, Pennsylvania, USA
Standard No. D5504-01 (2002)

The scope of the standard is described below.

- This test method is primarily for the determination of speciated, volatile, and sulphur-containing compounds in high methane content gaseous fuels such as natural gas. It has been successfully applied to other types of gaseous samples including air, digester, landfill, and refinery fuel gas. The detection range for sulphur compounds, reported as picograms sulphur, is ten to one million. This is equivalent to 0.01 to 1000 mg/m^3, based upon the analysis of a one cc sample.
- This test method does not purport to identify all sulphur species in a sample. Only compounds that are eluted through the selected column under the chromatographic conditions chosen are determined. The detector response to sulphur is equimolar for all sulphur compounds within the scope (1.1) of this test method. Thus, unidentified compounds are determined with equal precision to that of identified substances. Total sulphur content is determined from the total of individually quantified components.
- The values stated in SI units are standard. The values stated in inch-pound units are for information only.
- This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and to determine the applicability of regulatory limitations prior to use.

[Source: www.astm.org]

Government notification/ policy

Government of India clears downstream petroleum sector regulatory board

The Downstream Petroleum Sector Regulatory Board Bill was cleared by the Indian Cabinet on 18 April 2002. The Bill provides the regulator with wide-ranging powers to fix the ceiling prices for motor spirit and high-speed diesel and to regulate and monitor access to the common-carrier systems. The main features of this bill are described below.

- The Bill provides the Board with the powers to put a cap on the retail prices of motor spirit and high-speed diesel to prevent price profiteering, avoid abnormal fluctuation in prices and to promote competitive markets.
- The Bill empowers the Board to regulate and monitor access to the common-carrier systems and lay down the guidelines for setting transportation tariffs for the existing and new pipelines and associated facilities.
- The Board will also set usage charges for hydrant systems and distribution charges for natural gas. It will also have powers to grant, renew, suspend, and cancel authorization for laying

and operating common-carrier systems and associated facilities, including capacity expansion of existing pipelines.
- The Board will ensure that liquefied natural gas terminals are located in accordance with the policy of the Central Government. It will facilitate smooth exchange of petroleum products and hospitality arrangements in case of disruption of supplies.
- The Bill grants the Central Government powers to intervene whenever the board fails in matters of policy relating to the downstream petroleum sector.

Source: *Drilling and Exploration World* **11**(6): 9 (2002)

Calendar of events

Conferences, congresses, seminars, symposiums, and workshops

Oregon, USA
2-5 June 2002

Windpower 2002: Conference and Exhibition
American Wind Energy Association, 122 C Street, NW,
Suite 380, Washington, DC 20001, USA

Fax +1 202 383 2505 • *Tel.* +1 202 383 2500
Web site www.awea.org/conference

Baku, Azerbaijan
4-7 June 2002

The Ninth International Caspian Oil & Gas Exhibition and Conference
Spearhead Exhibition Limited, Coombe Hill House, Beverley
Way, London SW20 OAR, UK

Fax +44 20 8949 8186/8193/9868 • *Tel.* +44 20 8949 9222
E-mail caspian@spearhead.co.uk
Web site www.caspianoilgas.co.uk

New Delhi, India
5-8 June 2002

Global Management Programme for Senior Executive in the Oil & Gas Industry: Developing Industry Captains of the Future
Indian School of Petroleum, 48-49 Hotel Ranjit, Ranjit Singh
Marg, New Delhi – 110 002, India

E-mail petroinfo@indianschoolofpetroleum.com
Tel. +91 11 322 2322, 322 2377, 322 2301-3

Kuala Lumpur, Malaysia
9-11 June 2002

The Seventh Annual Asia Oil and Gas Conference: Surviving the Global Economic Uncertainties
The Conference Connection Inc., P O Box 1736, Raffles City,
Singapore 911758

Fax +65 226 4117/4092 • *E-mail* info@cconnection.org
Tel. +65 226 5280

Berlin, Germany
13-15 June 2002

Wind-Power-Expo: World Trade Fair for Renewable Energy
Profair, Consult+Project GmbH, An der Scharlake 33, D-31135
Hildesheim, Germany

Fax +49 5121 53640 • *E-mail* info@solarenergy-berlin.de
Web site www.solarenergy-berline.de

Berlin, Germany
13-15 June 2002

World Renewable Energy Policy and Strategy Forum
World Council for Renewable Energy, c/o EUROSOLAR,
e.V.-Kaiser-Friedrich-Str. 11, 53113 Bonn, Germany

Fax +49 228 361213 • *Tel.* +49 228 362373
E-mail info@world-council-for-renewable-energy.org
Web site www.world-council-for-renewable-energy.org

Nevada, USA
15-19 June 2002

Solar 2002: Sunrise on the Reliable Energy Economy
American Solar Energy Society, 2400 Central Avenue,
Suite G-1, Boulder, CO 80301, USA

Fax +1 303 443 3212 • *E-mail* ases@ases.org
Tel. +1 303 443 3130 • *Web site* www.ases.org

Amsterdam, The Netherlands
17-21 June 2002

12th European Conference and Exhibition on Biomass for Energy and Industry
WIP-Munich (exhibition), ETA Florence (conference), Germany

Fax +49 89 7201291 • *Tel.* +49 89 7201232
E-mail wip@wip-munich.de / eta.fi@etaflorence.it
Web site www.wip-munich.de / www.etaflorence.it

Chennai, India
21-23 June 2002

EEWAC 2002 Exhibition and Conference on Environment, Energy, Water and Clean Technology
Unitech Exhibition Private Limited, 92/3, 2nd Main Road,
Gandhi Nagar, Adyar, Chennai – 600 020, India

Fax +91 44 440 5492 • *Tel.* +91 44 440 5494, 440 5493
E-mail unitech@hathway.com, info@unitechexhibitions.com

Hampshire, UK
23-25 June 2002

Coal as a Commodity: The New Coal Market from Puberty to Maturity
The McCloskey Group, 2 Pages Court, St. Peter's Road,
Petersfield, Hampshire GU32 3HX, UK

Fax +44 1730 260 044
E-mail Amber.Bates@McCloskeyCoal.com
Tel. +44 1730 265 095 *Web site* www.McCloskeyCoal.com

Bologna, Italy
23-26 June 2002

ISES: EuroSun 2002 Conference
EuroSun2002 Secretariat ISES ITALIA, Pazza Bologna,
22-00162 Rome, Italy

Fax +39 6 4424 9243 • *E-mail* eurosun2002@isesitalia.it
Tel. +39 6 4424 9241 • *Web site* www.isesitalia.it/eurosun2002.htm

Crete, Greece
25-28 June 2002

Second IASTED International Conference on Power and Energy System: EuroPES 2002
ASTED Secretariat-EuroPES 2002, #80, 4500-16th Avenue
NW, Calgary, Alberta, Canada T3B OM6, Canada

Fax +1 403 247 6851 • *E-mail* calgary@iasted.com
Tel. +1 403 288 1195 • *Web site* www.iasted.org

Aberdeen, UK
26-29 June 2002

25th Annual IAEE International Conference
Ms Pamela Strang, IAEE Conference Secretariat, Room 25,
University of Aberdeen, Regent Walk, Aberdeen Walk,
Aberdeen AB24 3FX, UK

Fax +44 1224 272 271 • *Web site* www.abdn.ac.uk/iaee

Cologne, Germany
1-3 July 2002

Renewable Energy 2002
Helen Beckett, Reed Exhibition Companies Ltd, Oriel House,
26 The Quadrant, Richmond, Surrey TW9 1DL, UK

Fax +44 20 8910 7810 *E-mail* helen.beckett@reedexpo.co.uk
Tel. +44 20 8910 7893 *Web site* www.renewenergy.com

Cologne, Germany
1-5 July 2002

World Renewable Energy Congress VII & Exhibition
Prof. Ali Sayigh, Chairman, 147 Hilmanton, Lower Earley,
Reading RG6 4HN, UK

Fax +44 118 961 1365 • *E-mail* asayigh@netcomuk.co.uk
Tel. +44 118 961 1364 • *Web site* www.wrenuk.co.uk

Lucerne, Switzerland
1-5 July 2002

Fuel Cell 2002: 2nd International Fuel Cell Conference with Exhibition
European Fuel Cell Forum, Morgenacherstrasse 2F,
P O Box 99, CH-5452 Oberrohrdorf, Switzerland

Fax +41 56 496 4412 • *E-mail* info@efcf.com
Tel. +41 56 496 7292 • *Web site* www.efcf.com

Bangkok, Thailand
1-19 July, 2002

A Training Workshop on Power System Planning, Operation and Management
Dr Weerakorn Ongsakul, EPSM, Asian Institute of Technology,
P O Box 4, Klong Luang Pathumthani 12120, Thailand

Fax +66 2 524 6589 • *E-mail* epsm@ait.ac.th
Tel. +66 2 524 5437, 524 6219

Berlin, Germany
4-8 July 2002

1st World Wind Energy Conference and Exhibition
WIP-Munich, Sylvensteinstr.2, D-81369 Munich, Germany

Fax +49 89 720 1291 • *E-mail* wip@wip-munich.de
Tel. +49 89 720 1235
Web site www.wip-munich.de, www.world-wind-conference.org

Toronto, Canada
17-19 July 2002

IGHEM 2002 (International Group for Hydraulic Efficiency Measurement)
Albert Mikhail, Ontario Power Generation, 700 University
Avenue, Toronto, Ontario M5G 1X6, Canada

Fax +1 416 592 7518 • *E-mail* albert.mikhail@opg.com
Tel. +1 416 592 7328 • *Web site* www.opg.com

Oregon, USA
29 July - 2 August 2002

HydroVision 2002
HydroVision 2002, 410 Archibald Street, Kansas City,
MO 64111, USA

Fax +1 816 931 2015 • *E-mail* hydrovision@hcipub.com
Tel. +1 816 931 1311 Ext.129 • *Web site* www.hcipub.com

California, USA
18-23 August 2002

Teaming for Efficiency: 2002 ACEEE Summer Study on Energy Efficiency in Buildings
ACEEE 2002 Summer Study Office, Attn: Rebecca Lunetta,
Conference Manager, P O Box 7588, Newark, DE 19714-7588,
USA

Fax +1 302 292 3965 • *E-mail* rlunetta@erols.com
Tel. +1 302 292 3966 • *Web site* http://aceee.org

Grenoble, France
2-5 September 2003

European Hydrogen Energy Conference
Ms Stephanie Paysant, Maison de la Chimie-28, rue Saint,
Dominique-75007, Paris, France

Fax +33 1 4555 4033 • *E-mail* afhparis@aol.com
Tel. +33 1 5359 0211 • *Web site* www.afh2.org

Kolkata, India
20-22 September 2002

Workshop on Energy Efficient and Environment Friendly Technologies for Rural Development (EETRD-2002)

Prof H S Ray, Chairman, Workshop Organising Committee anc
Emeritus Scientist, Central Glass and Ceramic Research Institute, 196, Raja S C Mullik Road, Kolkata – 700 032, India

E-mail hs_ray@yahoo.com • *Tel.* +91 33 473 3496, 473 3469

Amsterdam, The Netherlands
25-26 September 2002

Fuel Cells Science and Technology 2002

Claire Norris, Fuel Cells 2002, Conference Secretariat Eventiv
51 Kestrel Way, Wokingham, Berkshire RG41 3HA, UK

Fax +44 118 377 4696 • *E-mail* claire@eventive.org.uk
Tel. +44 118 377 4696 • *Web site* www.fuelcelladvances.com

Bhopal, India
28-29 September 2002

International Conference on Recent Advance in Solar Energy Conversion Systems

Organising Secretary, Dr S S Arora, Training and Placement Officer, Maulana Azad College of Technology (An Autonomous Regional Engineering College), Bhopal, Madhya Pradesh – 462 007, India

E-mail tpwmact@hotmail.com • *Tel.* +91 755 670 802, 670 894

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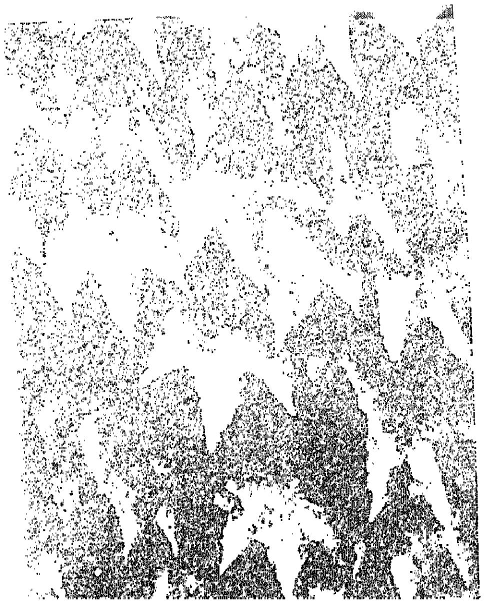
Monitor on
Environmental
Science



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Lodhi Road
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Darbari Seth Block, Habitat Place
Lodhi Road
New Delhi – 110 003

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    Mrinal K Ghose

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Centre of Mining Environment
Indian School of Mines
Dhanbad - 826004

Mrinal K Ghose

Controlling of motor vehicle emissions for a sustainable city

TERI Information Digest on Energy and Environment 1(2): 273–282

Abstract

The air quality crisis in cities may be attributed mainly to vehicular emissions. Transportation systems are expanding everywhere. The capacity of routine monitoring networks and assessment in developing countries (including India) is usually limited to criteria pollutants. India has adopted the motor vehicles emission standards. The reduction of emissions through introduction of new control technology is being carried out. The control technology for gasoline engines, diesel engines, new engines, and vehicle technologies are discussed. Fuel modification for the reduction of emissions has also been discussed. Fuels derived from natural gas are of interest as clean fuels. LPG (liquefied petroleum gas), CNG (compressed natural gas), ethanol, and electricity are still of very limited use for motor vehicles. Monitoring of the ambient pollutant level of in-use vehicles showed greater values than the predicted values. Current inspection and maintenance programmes have been narrated and motor vehicles strategies have been discussed.

In developing countries the air quality crisis in cities is often attributed in large measures (40%–80%) to vehicular emissions. Most of the cities are growing rapidly. Moreover, urban populations are growing at a faster rate than national averages, as subsistence workers migrate from rural areas to the cities in search of disposable income. Existing cities are expanding and new cities are coming up. This rapid growth of the urban population also brings with it an increasing demand for energy-based goods and services. Urban India depicts a picture of metamorphosis. The feudal towns have changed to industrial cities, cities into metropolises, and metropolises into megalopolises. Owing to the expanding economic base, there is an influx of people migrating from the rural areas and urban fringes to the core city in search of a better life. The economic statistics reveal an increasing contribution of urban areas to the GDP (gross domestic product). These had contributed only 29% of the GDP in 1950/51, which increased to 47% in 1980/81 and to 60% in 2000/01. The influx of people to the existing cities stresses the already overstretched infrastructure of the urban areas and is unable to cater to the ever-growing needs of in-migrants consequently.

sclaimer The views expressed by the authors are not necessarily those of the organizations to which they belong nor ould the articles be viewed as representing the policy of either the Ministry of Environment and Forests or TERI.

The improved performance of technology is presently insufficient to counteract the growth of transportation systems. Projections, therefore, consistently show worsening air quality in the cities of India in the future. Rapid technological advancement represents the only real hope for fulfilling the legitimate aspirations of the people of India for a higher standard of living without severe deterioration of the environment (Streets, Heydayat, Carmichael *et al.* 1999). Over the last few years, the World Bank funded projects have come under close scrutiny to ensure the required environmental assessment. The present paper describes the evaluation of the motor vehicle emission control strategy and its implementation and results.

Effects of urban air pollution on human health

The total exposure of an individual to a specific pollutant is determined by the concentration of contaminant and the duration of exposure (Spengler and Dockery 1981). The exposures to indoor and outdoor air qualities are different because they always vary with the time and the diurnal pattern (TERI 1995). The health status and the exposure level of a typical population which is homogenous in terms of habitat, drinking water source, indoor microclimate, domestic fuel consumption, movement pattern, overall living standards, general sense of health and hygiene, literacy and interaction with locality, and work place are reported (CPCB 1997). Certain kinds of air-borne dust such as pollen, fungal spores, house dust mite, and animal dander (Tilak 1989) upon inhalation cause certain allergic reactions in the respiratory system such as rhinitis, tropical diseases, and asthma (Fernandes 1995, Arruda, Mann, and Chapman 1992). Secondary photolytic reactions in the atmosphere with organic fractions and oxides of nitrogen and sulphur further increase the PAH (polycyclic aromatic hydrocarbon) concentration. These are of marked environmental concern for air pollution as several of them are either known to be carcinogens or are suspected carcinogens and mutants (Hoffmann and Wynder 1968, Andrews, Thibault Lijisky 1978). Exposure to SPM (suspended particulate matter) is also an equally serious risk to health. Inhalable SPM particularly less than 10 micron in size can pass through the natural protective mechanism of human respiratory system. The smallest particulate matter (2 micron or less), which come primarily from diesel pose a much greater risk because of their greater ability to pass through the human respiratory system and cling to the inner tissue of the lung. It has been reported that more than 10 000 premature deaths occurred in Kolkata in 1995 due to SPM (Kazimuddin and Banerjee 2000). SPM includes all air-borne particles in the size range of 0.5 micron to 100 micron. The actual health damage caused by dust particles depends upon their nature and composition (Binder, Mitchell, Hosein *et al.* 1976). The effects of SPM attributed to mild eye irritation (David 1995). According to the Health Care Institute of India, there is an alarming rise in the number of patients in Delhi hospitals with respiratory problems (*Indian Express* 1996).

Automobile exhaust and certain industrial pollutants contain NO_2, which by photochemical reaction produces O_3 and effects allergic asthmatics by augmenting allergic responses (Steinberg

Janel, and Gilson,1991). Similarly, SO_2, NO, particulate matter, and acid aerosols effect the pulmonary function and cause inflammation of the bronchial mucus (Karen and Michak 1991). It has been observed from several studies that air pollution plays an important role in the genesis and augmentation of allergic disorder and it is described as a disease of civilized society (Dennis 1996, Bonini, Magrini, Rotiroti *et al.* 1994). Most of the developed western countries have adopted 25 mg/dl and 1.5 mg/dl as the safe limits for blood-lead levels in adults and children respectively (Neelman 1993). In view of toxicity at all levels, options have been expressed to adopt 10 mg/dl as the blood lead limit for the general population (Boeck 1986).

Control technology in engines

Several engine design characteristics favour lower hydrocarbon emission. Since much of the hydrocarbon emission is caused by wall quench, any reduction of the surface–volume ratio of the combustion chamber decreases the hydrocarbon emission. Factors which reduce the surface–volume ratio are a decreased compression ratio, a more spherical combustion chamber shape, increased displacement per engine, and an increased ratio of the stroke relative to bore. The air–fuel ratio in the internal combustion engine has a marked effect upon the emission of hydrocarbons. As the air–fuel ratio becomes richer in fuel than the stoichiometric ratio, the emission of hydrocarbon increases sharply. There is a moderate decrease in hydrocarbons emission when the mixture becomes appreciably leaner in fuel than the stoichiometric ratio requires. The lowest level of hydrocarbons emission occurs at an air–fuel ratio that is slightly leaner in fuel than the stoichiometric ratio. This behaviour is explained by a combination of factors, including the minimum quench layer at an air–fuel ratio somewhat richer than the stoichiometric ratio, decreasing hydrocarbon concentration in the quench layer with a leaner mixture, and a peak exhaust temperature at a ratio slightly leaner in fuel than the stoichiometric ratio. Various catalytic exhaust reactors have been devised for the oxidation of hydrocarbons and CO (oxidation catalyst) and the reduction of NO (reduction catalyst). The noble metals (Pd, Pt, and Ru) and non-stoichiometric oxides (Fe_2O_3, CoO, and Cr_2o_2) may be employed as oxidation catalysts (Edwards 1974). Noble metals, base metals, or oxides may catalyze the reduction. Rhodium is the most widely used reduction catalyst, but tends to be in short supply (Anon 1980).

Regulations for evaporative hydrocarbons and refuelling emissions currently represent about 90% reduction from uncontrolled vehicles. California has adopted a zero evaporative refuelling emission standard beginning 2004 (Harley, Sawyer, Milford 1997). Most other vehicle emissions standards, international harmonization of emission standards, and test methods are yet unrealized goals. The reduction of emissions through introduction of new control technology is occurring internationally. Fuel-air preparation, combustion control, and exhaust gas treatment, have all contributed to the reduction of exhaust emissions. This is made possible by the computer control technology. The use of improved materials and management of fuel tank vapours has reduced the evaporative emissions of hydrocarbons.

Gasoline engines

Modern gasoline engines use computer-controlled intake port fuel injections with feedback control based on an oxygen sensor to precisely quantify the fuel delivered to the engine. Control of in-cylinder mixing and use of high-energy ignition promote nearly complete combustion. The three-way catalyst provides greater than 90% reduction of carbon monoxide, hydrocarbons, and oxides of nitrogen. The design for rapid warm-up minimizes cold start emissions. The OBD (on-board diagnostic) system can sense emission systems performance and identify component failures. Durability in excess of 16 000 km with minimal maintenance is now common.

Diesel engines

The control of diesel engine emissions has been less impressive. Although they have inherently low carbon monoxide and exhaust and evaporative hydrocarbons, diesels emit high levels of NO_x and particulate matter. To date exhaust gas recalculation has provided NO_x control (Dreher and Harley 1998). A very high pressure computer control fuel injection reduces particulate emissions. Further reduction of NO_x and particulate matter requires exhaust treatment. Lean traps with periodic reduction and filter traps with periodic burn-off are evolving and promising technologies. A new type of diesel, the homogeneous charge compression ignition engine, provides another approach to reducing NO_x and particulate matter.

New engine and vehicle technologies

In the long term, battery, electric, and fuel-cell vehicles may play a role but their use will be limited as long as petroleum fuels remain abundant and inexpensive. Hybrid vehicles with combustion engines – generators, battery energy storage, electric drive, and regenerative braking – are now in production. They provide greatly improved fuel economy and could be important in the reduction of CO_2 emissions.

Control technology in fuels

Due to the increase in human population, personal vehicles, and industrial activities in Indian cities, the ambient air quality has been affected to a great extent. The average data collected by the CPCB (Central Pollution Control Board) and the NEERI (National Environmental Engineering Research Institute) showed an increasing trend in the levels of pollutants in the air. The ambient air quality trends in major cities indicate that the levels of SPM are higher than the limits prescribed by the CPCB. The levels of oxides of nitrogen are increasing in the urban centres with vehicular emissions. Monitoring of ambient air quality in areas of high traffic density at traffic junctions indicates that the levels of NO_x and CO are exceeding the ambient air quality standards. The study revealed that the maximum share of air pollution in metro cities is contributed by vehicular emissions. Therefore, necessary steps to control vehicular emissions are being taken on priority. Gross emission for on-road vehicles and mass emission standards for all categories of new vehicles had been notified under the Central Motor Vehicles Rules, 1989 and are being enforced by the department of transport in various states. For controlling pollution from vehicles, emission norms for both petrol- and diesel-driven vehicles, at the manufacturing stage, were introduced in 1990 and made tighter in 1996. More stringent emission norms came into effect in 2000. A system of synchronized signals for better traffic management at most traffic intersections is being introduced. Fuel modification is another approach to reducing motor vehicle emissions. This can take the form of reformulated gasoline and diesel or the introduction of alternative fuels.

Gasoline

The use of exhaust gas treatment requires the elimination of lead from gasoline. This change, which is occurring worldwide, has resulted in a dramatic reduction of ambient lead levels. Other gasoline properties that can be adjusted to reduce emissions include, roughly in order of effectiveness, sulphur level, vapour pressure, distillation characteristics, light olefin content, and aromatic content—the properties of the highly reformulated gasoline (CARFG-2) now sold in California. MTBE (methyl tertiary-butyl ether) is being phased out of CARFG-2 because of groundwater contamination problems. Gasoline reformulation similar to that of California is being adopted in the rest of the US and Europe. Emission reductions are substantial and importantly apply to all the vehicular fuels. In India, steps have been taken to ban leaded petrol. In the second phase, the Ministry of Petroleum and Natural Gas (Government of India) introduced unleaded petrol (less than 0.013 g/litre) in 1995 in four metro cities for 4-wheeler petrol vehicles fitted with catalytic converters. From 1998, unleaded petrol was introduced for all vehicles in Delhi. This was extended to the entire country from 1 April 2000. The programme of introduction of unleaded petrol is given in Table 1.

Table 1 Gasoline lead phase-out programme in India

Phase	*Period*	*Type of gasoline*	*Place(s)*
I	June 1994	Low leaded (0.15 g/l)	Delhi, Mumbai, Kolkata, and Chennai
II	April 1995	Unleaded (0.013 g/l) and low leaded	Delhi, Mumbai, Kolkata, and Chennai
III	January 1997	Low leaded	Entire country
IV	September 1998	Ban on leaded fuel	Delhi
V	September 1998	Unleaded and low leaded	All other capitals of states/union territories and other major cities
VI	January 1999	Unleaded only	Delhi
VII	April 2000	Unleaded and low leaded	Entire country

Diesel

Diesel catalysts' capability of reducing the particulate emission of diesel buses is widely recognized. Both the US and Sweden have made it mandatory for large buses to be retrofitted with diesel catalysts to lower the exhaust emissions. The US has a programme of certifying diesel catalysts that have a minimum particulate reduction efficiency of 25%. London has also about 1000 double-decker buses fitted with diesel catalysts. An increasing number of countries are trying diesel catalysts. Reformulated diesel fuels can effectively reduce nitrogen-oxide and particulate emissions. These fuels have reduced sulphur and aromatics and increased the cetane number. Extremely low (5 ppm [parts per million] or less) sulphur fuels may be required by the proposed NO_x shortage catalyst (Arndt, Carmichael, Streets *et al.* 1997). Other potential modifications include the

Table 2 Diesel sulphur phase-out programme in India

Phase	*Period*	*Type of sulphur*	*Place(s)*
I	April 1996	Low sulphur (0.5%)	Delhi, Mumbai, Kolkata, Chennai, and the Taj Trapezium
II	August 1997	Low sulphur (0.25%)	Delhi, Taj Trapezium
III	April 1998	Low sulphur (0.25%)	Delhi, Mumbai, Kolkata, and Chennai
IV	April 1999	Low sulphur (0.25%)	Entire country

addition of oxygenated catalysts to reduce particulates and the addition of metals to improve the particulate trap or oxygen catalyst performance. A programme was launched for low-sulphur diesel in metropolitan cities in India in 1997 and then extended to the entire county (Table 2).

Alternative fuels

Alternatives to gasoline and diesel are of interest because they provide a market for petroleum by-products, offer reduced emissions, and/or come from non-petroleum resources. LPG, CNG, and ethanol are common, but of limited use. Natural gas-derived fuels, such as methanol, dimethyl, and ethers, and Fischer–Tropsch diesel are of interest as clean fuels, which provide a new market for natural gas. Electricity is beginning to see increased demands but is still of very limited use as a motor vehicle fuel.

In-use emissions and their reduction

Improvements in air quality and reduction in emissions from the in-use vehicle fleet are less than would be anticipated from the stringent emission regulation, new emissions control technology, and clean fuels (Calvert, Haywood, Sawyer *et al.* 1993). Monitoring of ambient pollutant levels, measurement of on-road vehicle fleet emissions in tunnels, remote-sensing of on-road vehicle emissions, and chassis dynamometer testing of in-use vehicles consistently indicate that emission levels are greater than the predictions of the emission standards. Combined with a continuing increase in motor fuel consumption and vehicle kilometre travel that the individual vehicle emissions cause, motor vehicles will remain at the centre of the air pollution problem.

The discrepancies seem to be greatest for high duty gasoline vehicle emissions of hydrocarbons and carbon monoxide and for heavy-duty diesel truck and bus emissions of oxides of nitrogen (Winebrake and Deatton 1997). The cause of these excess in-use emissions is complex and not fully understood. In part they result from a failure of the vehicle certification test procedure to capture how the vehicles are actually driven. Light duty vehicles are now driven at higher speeds and with greater accelerations than are represented in the FTP (Federal Test Procedure) driving cycle. Driver behaviour, air conditioning us, and road grade, all effect emissions but are not reflected in standard testing methods. All these conditions tend to increase the frequency of enrichment, leading to higher hydrocarbons and carbon monoxide emissions. Engines for heavy-duty trucks are certified by a transient test conducted on an engine dynamometer. These engines are then installed in a variety of applications. The tunnel test (Miguel, Kirschsetter, Harley 1998) and heavy-duty bus chassis dynamometer tests (Ramamurty and Clark 1999) of in-use vehicle show that NO_x emissions greatly exceed the emission standards for which they were certified. The reasons for these differences are not well understood. The engine dynamometer test procedure apparently does not reflect how the engine is used in a heavy-duty vehicle under real world conditions. It is also known that the fuel-injection timing is re-optimized for improved fuel economy under some on-road operating conditions. If these observations apply broadly to the heavy-duty diesel fleet, current emissions are at uncontrolled levels.

In-use deterioration results from normal aging of engine, emissions control components, and lack of maintenance by owners and operators. New light-duty vehicles demonstrate much-improved durability but they remain in service longer and accumulate a greater number of kilometres than the vehicles they replace. About 10% of the vehicles (high metres) are responsible for 50% of emissions. Current inspection and maintenance programmes, which are really inspection and repair programmes, have not yet proved an effective means of identifying and repairing high emitting vehicles. On-board dynamic systems may assist in identifying and repairing high emitting vehicles.

Motor vehicle control strategies

In general, emissions from motor vehicles are minimized if the vehicles are warmed up, operating at a steady-state speed of 50 km/hour. The components of the normal driving cycle – acceleration, cold start, driving before warming up, stop- and-go conditions, and period of idling at signals – are to be added. Improvements in urban infrastructure can, therefore, result in a net decrease in vehicular emissions, all other factors being equal. Infrastructure may even act as an incentive to faster growth in the vehicular fleet as an alternative to the use of public transport. The improved traffic flow may offer only a short-term improvement in urban traffic movements and only a short-term reduction in emissions. The uncontrolled growth of the vehicle fleet following the improvement to the road system represents the worst outcome, in terms of urban air quality. In order to prevent this from happening, it is necessary to use the time *bound* by the project to develop and implement a strategy for the reduction in vehicle emissions. Where resources are limited, there must be a policy and commitment to ensure that the worst-case scenario does not develop. The most desirable outcome is that the project gives enough working time for control measures to come and begin to take effect.

The elements of the vehicle emission control strategy range from short-term, early action, measures to long-term policy and technological research actions. The diverse range of measures is essential to the success of the programme. Table 2 shows one form of a breakdown of the measures. In the development of vehicle control strategies, a cost–benefit analysis should be undertaken where the control measures and effectiveness are taken into account. This analysis generally results in a further classification of measures as short-, mid-, and long-term and as high, medium, and low priority. At that stage, policy- and decision-makers can balance the programme goals and resources. A successful programme will incorporate several component measures. Reliance on a single measure will take years to exert a measurable influence on the fleet. Some other measures can achieve more rapid results. There are some widely quoted statistics about the highly skewed distribution of emissions in a vehicle population to the effect that 75% of the emissions are produced by 25% of the vehicles. The logical implication is that a programme that would identify those vehicles, to meet the average emission rate of the rest of the fleet, would result in an overall reduction of about two-thirds. Therefore, there is great appeal in a vigorous and stringent inspection and maintenance programme to effect there measures. A similar reduction in emissions through the penetration of new vehicles into the fleet would take much longer. The strategy for vehicle emission control will, in all cases, involve a number of different compulsory measures. Each must be assessed in terms of feasibility and cost/benefit in each specific application.

Conclusion

Even with the introduction of advanced emission control technology and clean fuels, motor vehicles remain the dominant source of urban air pollution. Addressing this problem requires a better understanding of the source and cause of emissions and an effective means of addressing in-use emissions. Current inspection and maintenance programmes have not proved an effective means of identifying and repairing high emitting vehicles. The strategy for emission control should involve a number of different measures and must be assessed in terms of feasibility and cost/benefit. The development of an integrated motor vehicle emission control strategy is a key component of urban environmental management systems to improve air quality.

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Statistical capsule

Table 1 Status of municipal solid waste treatment and disposal in metro cities

City	*Solid waste collection* (tonnes/day)	*Treatment* (tonnes/day)	*Mode of disposal* (%)		
			Dumping	*Composting*	*Others*
Ahmedabad	1683	84	95	5.0	–
Bangalore	2000	200	90	10.0	–
Bhopal	546	100	82	18.0	–
Chennai	3124	–	100	–	–
Coimbatore	350	–	100	–	–
Delhi	4000	300	93	7.5	–
Hyderabad	1566	100	94	6.0	–
Indore	350	50	86	14.0	–
Jaipur	580	–	100	–	–
Kanpur	1200	300	75	25.0	–
Kochi	347	–	100	–	–
Kolkata	3692	–	100	–	–
Lucknow	1010	–	100	–	–
Ludhiana	400	–	100	–	–
Madurai	370	–	100	–	–
Mumbai	55 355	500	91	9.0	–
Nagpur	443	–	100	–	–
Patna	330	–	100	–	–
Pune	700	50	93	–	7
Surat	900	225	75	25.0	–
Vadodara	400	100	75	–	5
Varanasi	412	–	100	–	–
Visakhapatnam	300	–	100	–	–

Source CPCB. 1999. **Status of solid waste generation, collection, and disposal in metro cities.** New Delhi: Central Pollution Control Board.

Table 2 Status of hazardous waste generation in India

State/Union Territory	*Number of units generating hazardous waste*	*Quantity of waste generated and segregated by type of waste* (tonnes/year)			
		Recyclable	*Incinerable*	*Disposable*	*Total*
Ahmedabad	501	61 820	5 425	43 853	111 098
Assam	18	–	–	166 008	166 008
Bihar	42	2 151	75	24 351	26 577
Chandigarh	47	–	–	305	305
Delhi	–	–	–	–	59 423
Goa	25	873	2 000	3 725	8 742
Gujarat	2 984	26 000	19 953	150 062	430 030
Haryana	309	–	–	31 046	32 559
Himachal Pradesh	116	–	63	2 096	2 159
Karnataka	454	47 330	3 328	52 585	103 243
Kerala	151	84 932	5 069	690 014	780 015
Maharashtra	3 953	847 436	5 012	1 155 398	2 007 846
Madhya Pradesh	183	89 593	1 309	107 767	198 669
Orissa	163	2 841	–	338 303	341 144
Jammu and Kashmir	57	–	–	–	1 221
Pondicherry	15	8 730	120	43	8 893
Punjab	700	9 348	1 128	12 233	22 745
Rajasthan	306	9 487	19 866	2 242 683	2 272 036
Tamil Nadu	1 100	193 507	4 699	196 002	401 073
Uttar Pradesh	1 020	–	–	–	140 146
West Bengal	440	45 233	50 894	33 699	129 826
Total	12 584	1 429 281	118 941	5 250 173	7 243 758

Source MoEF. 2000. Draft paper on status of implementation of the hazardous wastes rules 1989. New Delhi: Ministry of Environment and Forests.

Table 3 Municipal solid waste generation (kg per capita per day) in cities and towns

City/town	*1971-73*	*1986/87*	*1994*
Ahmedabad	0.24	–	0.59
Ajmer	0.24	0.44	–
Allahabad	0.20	0.50	–
Aurangabad	0.42	0.67	–
Bangalore	0.32	–	0.48
Baroda	0.29	–	0.39
Bhopal	0.26	–	0.51
Bikaner	0.29	–	–
Chandigarh	0.36	–	–
Chennai	0.32	–	0.66
Coimbatore	0.31	–	0.43
Delhi	0.21	–	0.48
Gorakhpur	0.21	0.64	–
Guwahati	0.24	–	–
Gwalior	0.27	–	–
Howrah	0.59	–	–
Hyderabad	0.33	–	0.40
Jabalpur	0.30	–	0
Jaipur	0.28	–	0.40
Jodhpur	0.20	0.45	–
Kanpur	0.55	–	0.64
Kochi	–	0.27	0.52
Kolkata	0.50	–	0.34
Kota	0.25	0.40	–
Kozhikode	0.15	0.16	–
Kurnool	0.20	–	–
Lucknow	–	–	0.62
Ludhiana	–	0.40	0.40
Madurai	0.38	–	0.39
Mumbai	0.49	–	0.44
Nagpur	0.22	–	0.27
Patna	0.48	–	0.36
Pune	0.24	–	0.31
Raipur	0.32	0.23	–
Rajkot	0.07	0.21	–
Sangli	0.23	0.30	–
Surat	0.15	–	0.60
Tatanagar	0.45	–	–
Thane	0.23	–	–
Tiruchirappalli	0.21	–	–
Thiruvananthapuram	0.12	0.34	–
Udaipur	0.14	–	–
Vadodara	–	–	0.39
Varanasi	–	–	0.40
Vijayawada	0.17	0.44	–
Visakhapatnam	–	0.31	0.40

Source TERI. 2001. TEDDY (TERI Energy Data Directory & Yearbook) 2001/02, p. 379. New Delhi: Tata Energy Research Institute.

Techno newsbriefs

From newspapers, magazines, and trade journals

Garbage volume reduction

Asia-Pacific Tech Monitor 19(1): 10 (2002)

The JSTC (Japan Science and Technology Corporation) has adopted a high-speed volume reduction system of garbage, based on a research at the Osaka Prefectural Industrial Technology Research Institute. The vegetables and fruits that lose market value and the garbage from processing of marine products total about 250 000 tonnes per year. At present, these products are subject to incineration. Since the garbage is generated in large quantities and consists of 90% water, its incineration is difficult and costly. In the new technology, the garbage is decomposed by microbiological treatment, which reduces its volume in a short period, and a system has been developed to deal with a maximum of 50 tonnes of garbage every day. An air-supply unit is installed in a rotary kiln type fermentation vessel, and aerobic fermentation is accelerated by supplying sufficient air into the fermentation vessel. High-speed volume reduction is achieved by maintaining the temperature, water content, and the like in the fermentation vessel at proper values to stabilize the progress of fermentation and to absorb the fluctuation in the properties of garbage.

Japan: recycling law on cars planned

Warmer Bulletin 84: 3 (2002)

The Japanese Ministry of Economic, Trade and Industry plans to submit a Bill to establish an automobile recycling law designed to boost the recycling of scrapped vehicle components and reduce waste. If the Bill is approved in the cabinet meeting, it will then be presented at the Diet Session in the hope that it would become a law in 2004. If enacted, purchasers of new vehicles will be required to pay a recycling fee set by automobile-makers when buying the motor. The fee will also be imposed on vehicles sold before the law is enforced, with owners of such vehicles obliged to pay the recycling fee before the first inspection of their vehicles after the establishment of the law. The Bill also stipulates that vehicles cannot be inspected if the owners do not have a certificate to prove that they have paid the recycling fee. Car dealers and garages will be asked to refuse to scrap the vehicles unless the owners produce the certificate proving the payment of the fee. The recycling law is designated to encourage drivers to recognize the importance of recycling/reusable components by imposing fees on them regardless of when the vehicle is purchased. Although automobile-makers will be allowed to set the amount of the recycling fees for their models, it is expected that fees will be about 20 000 yen (£ 106). The Bill also stipulates that the government would call on automobile-makers to lower their fees if they were too high. According to the Bill, a planned third-party organization will manage the collected recycling fees, and the makers will be required to apply for money from the corporation when they conduct recycling works. The focus of dispute was whether the fee should be applied to cars purchased before the enforcement of the law. But it was agreed that recycling fees should be collected from owners of those cars before the first car inspection was conducted after the enactment of the law. As a result, the authorities will be able to collect the recycling fees from the owners of more than 70 million existing cars by the end of 2007.

Incinerator ash treatment technology—new process announced

Warmer Bulletin
84: 7 (2002)

A new energy-efficient thermal treatment process has been developed in the UK, which could offer a cheaper and safer way of dealing with millions of tonnes of toxic fly ash produced every year at incinerator plants across the UK. In this process, sintering takes place in an energy-efficient regenerative system, which heats ash particles to around 850 °C. Particles agglomerated as constituents are heated and softened. The regenerative ceramic burners use up to 50% less energy than other thermal treatment techniques. The regenerators are made up of closely packed alumina spheres which maximize the area for heat transfer, making it possible to remove virtually all the heat from the outgoing flue gases. Energy-efficient regenerative burners and specially designed cyclones are used in the sintering process that destroys toxic organic components such as dioxins and furans, and converts heavy metals into an unleachable form. Residual ash can be turned into pellets for use in construction applications such as roads or disposed of in normal landfill sites. From the burners, sintered particles and flue gases are separated in cyclones specially designed to achieve maximum efficiency. High temperatures are maintained throughout the cyclones to ensure that there is no reformation of dioxins and furans. Extensive tests were carried out on samples from the ash-detoxifying pilot plant. The results are regarded as exceptionally encouraging, eliminating any concern over the suitability of the sintered ash pellets for reuse. Concentrations of dioxins and furans are reduced below the detectable limit of 0.1 pg/g (picogram per gram). Up to 99.9% of some heavy metals including Pb are converted into metal oxides, reducing leaching potential by 96%, comparable to levels found in normal soil. Energy consumption and costs are cut by up to 50% by the heat regeneration process. Results of trials confirm that the process could provide a commercially viable alternative to existing solutions such as special landfill, which is being increasingly tightly regulated, and vitrification, which consumes far more energy. The technique could be applied to municipal, clinical, and industrial incinerators, saving millions of pounds a year.

Disposal of medical waste

Environmental Pollution Control Journal
5(3): 49-50 (2002)

Hospital wastes, such as dressings, blood bags, syringes, etc. are currently disposed of in the open, which pollute the environment. The TIFAC (Technology Information, Forecasting and Assessment Council) and the FCIPT (Facilitation Centre for

Industrial Plasma Technologies), a branch of the Institute of Plasma Research, Gandhinagar, have collaborated to develop a Plasma Pyrolysis Reactor for disposal of medical wastes. The technology uses a plasma furnace, which provides a minimum temperature of 3000 °C, to ensure complete incineration, and high fluxes of ultraviolet radiation to destroy pathogens completely. The gas flowing between two electrodes is ionized and ejected as plasma. The current passing through the plasma heats the gas to more than 10 000 °C. These plasma torches can be run with small quantities of gas flow with a conversion efficiency of 80%. The flame is directed at materials for pyrolysis and the reaction is instantaneous. Typical gaseous products from organic wastes are rich in H_2 and CO. Inorganic waste are reduced to a non-hazardous melt, with a low unburnt organic residue, that is less than 0.2% of total organic carbon. It eliminates all harmful residues as well as the highly toxic sticky and grease ash left in the conventional incinerating plants. The temperature in the primary chamber is more than 700 °C and its more than 15 000 °C in the secondary chamber. The emissions are far better than the CPCB norms. Under optimal conditions, the system can provide large quantities of CO and H_2 gases as by-products. The FCIPT is researching the use of these gases for direct fuelling of internal combustion engines. Trials have been conducted in simulated conditions and with actual hospital wastes at the Gujarat Cancer Research Hospital, Ahmedabad. TIFAC is now planning to put eight units of plasma incinerators at different hospitals across the country to demonstrate the efficiency of commercial operations. The technology is available for licensing to Indian industries.

Centre to formulate a comprehensive policy on occupational safety and health

Environmental Pollution Control Journal 5(3): 52 (2002)

The Government of India has decided to formulate a coherent and comprehensive national policy on occupational safety and health during the Tenth Five Year Plan. The policy will take into consideration the provisions in the International Labour Organization Convention No. 155 on Occupational Safety, Health and Working Environment. This was stated by the labour minister, Mr Sharad Yadav. The Government will also enact a general legislation on occupational safety and health for workplaces. Mr Yadav said that the extension of legislative cover would be ineffective without creating mass awareness on safety and health issues. He said that it has been decided to give thrust to seven segments namely agriculture, construction, shops and establishments, bidi and cigar manufacturing, homework, eating places, and waste management for undertaking large awareness campaign. He said that the Planning Commission has approved a substantial outlay for this purpose.

Recovering heavy metals from waste

Indian Journal of Environmental Protection 21(6): 553 (2001)

Scientists have developed a process that uses bio-adsorbers made from natural biological materials to bind heavy metals present in waste water. Outflows of industrial waste water containing heavy metals are a serious hazard to nature. At the same time, these outflows are of commercial value. The metal salts that these waste water contain are, therefore, recovered. Both thermal and membrane processes are employed to filter heavy metals from waste water and return them to the production cycle. The most common method at present involves precipitation reaction process using synthetic resin ion exchangers. In the ion exchanger, metal ions are bound to the resin and replaced by hydrogen ions. When ion exchanger is saturated, it is regenerated with an acid. The result is a highly concentrated acidic salt solution, which can be further condensed and an ion exchanger, which can be reused. One disadvantage of using synthetic resins as ion exchangers is that they are produced from petroleum, a limited source. The new process developed functions in the same way, but has far greater future promise. It uses bio-adsorbers ion exchangers of regenerative raw materials. Residual products of cereal processing are used instead of synthetic resins.

New Philippine President's first act is Waste Act

Warmer Bulletin 77(March): 15 (2001)

Alarmed by the worsening garbage problem in Manila, The Philippines, which threatens to throw the country into a public health crisis, President Gloria Arroyo has signed an Act—which deals with mountains of waste aimed at arresting similar problems throughout the country. The Act establishes mechanisms of waste minimization, resource recovery, appropriate collection and transport services, environmentally sound treatment and disposal of garbage. The Solid Waste Management Act includes many useful features such as, (1) mandatory segregation of waste at the household level, (2) collection vehicles to have appropriate compartments for sorted materials, (3) prohibition of open dumping of solid wastes, (4) establishment of sanitary landfills for final disposal, (5) recycling centres to be set up at every *barangay* (village level) nation-wide, (6) integration of solid waste management concerns in the school curriculum starting from the elementary level, and (7) preparation of ten-year waste plans by all local government units. The law empowers local government units to actively pursue solid waste management systems in their areas of jurisdiction by providing whatever policy and technical support is needed. Implementation of the act is expected to significantly reduce the volume of waste for disposal, alleviating the current pressures on the capacity of sanitary landfills.

Fluorescent molecule detects metal pollutants

Indian Journal of Environmental Protection 21(8): 248-249 (2001)

A team of Brigham Young University researchers has created molecules that glow in the presence of certain metal pollutants, paving the way for an early warning system that can alert regulators to the contamination of drinking water and waste streams. As excess of certain metals in a person's diet pose a health threat, the researchers devised the molecules as an improved method of detecting and monitoring increased metal levels in the environment caused by mining, smelting, fossil fuel combustion, and industrial use. This research will help creating a sensor that continually measures metal in a sample of water as it flows by, making it easier to respond to the problems more quickly. To detect metals – like zinc – in water, the researchers first created compounds that seek out and bind to metal ions—those atoms with extra electrons. Next, they created small molecules that attach to the metal-binding compounds. The small molecules reveal the presence of bound metal ions by acting as fluorescent *reporters*, which glow brightly when ultraviolet light is shined on them. If no metal ion is bound, the compounds remain dark. The colour of the glow depends on the type and concentration of the metal ions present.

New remedy for vehicular pollution

Indian Journal of Environmental Protection 21(10): 959-960 (2001)

A foreign firm, which had developed a technology of emulsifying water with diesel, claims that this can reduce particulate emission by up to 80% as well as reduce smoke from vehicles. The theory behind the process is that mixing water with fuel reduces the temperature combustion and allows the fuel to atomize more finely, drastically improving engine emissions. Since the production of nitrous oxides requires high temperatures, emulsification, which reduces the combustion temperature, also reduces the production of the polluting compounds. The particular advantage of emulsification is that it does not require installation of expensive infrastructure or engine modifications. Emulsified diesel can be used in new or old engines without modifications and the fuel can be distributed through existing tanks, lines, and pumps. The technology is already in commercial use in the US, UK, France, and Italy.

New solar technology for hazardous water treatment

Indian Journal of Environmental Protection 21(10): 960 (2001)

Researchers have developed an innovative solar technology that enabled the treatment of non-biodegradable and hazardous organic water contaminants, through an environment-friendly and cost-effective detoxification process. Hazardous organic water contaminants are commonly found in effluents from industrial activities, such as pharmaceutical manufacturing, printing, car coating, textile, and paper industries. Several compounds, including NBCS (non-biodegradable chlorinated hydrocarbon solvents) are not possible to remove using traditional waste water treatment methods. The new technology that will be helpful in breaking these contaminants into mineral compounds using solar light was developed and successfully tested. The reaction takes place when UV light excites a semiconductor catalyst (TiO_2) in the presence of oxygen; the hydroxyl (OH) radicals that are generated attack contaminants, producing a progressive breaking up of molecules into CO_2, H_2O, and diluted mineral acids. This solar photo-catalyzed detoxification process was validated through the construction of a demonstration plant. The plant worked efficiently even without sunlight due to the use of static solar collectors that can capture the diffused UV light as well as the direct beam. Apart from its simplicity, this innovative technology is also cost-effective, easy to use, and requires minimal capital investment.

Abstracts of current research

- Abstracts grouped under 14 headings
- Every abstract verified against the original source
- Photocopies of original documents available
- All published abstracts (1296 records so far) available for search
- List of source documents consulted for this issue appears below

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Subject

Fossil fuels and environment

Renewable energy and environment

Industrial pollution

Power sector and environment*

Transportation and environment

Hazardous wastes

Global environmental issues

Health effects

Control technologies

Environment planning, management, and policy issues

Environmental laws and regulations*

Environmental economics

Sustainable development

General*

Source documents

Journal	Year, volume, and issue
Atmospheric Environment	2002: **36**(2), **36**(12)
Bio Energy News	2001: 5(2), 5(4)
Current Science	2002: **82**(1), **82**(5), **82**(6)
Energy Policy	2002: **30**(5)
Energy Sources	2002: **24**(1)
Environmental Impact Assessment Review	2002: **22**(2)
Environmental Monitoring and Assessment	2002: 74(3), 75(2)
Environmental Pollution Control Journal	2002: 5(3)
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Indian Journal of Environmental Protection	2001: **21**(7), **21**(8), **21**(9), **21**(10)
Journal of Energy & Applied Science	2001: **20**(2)
Journal of Environmental Management	2001: **63**(1), **63**(2)
Resources, Conservation and Recycling	2002: **34**(3), **35**(3)
Water Research	2002: **36**(6)

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* No abstracts on the topic appear in this issue

Fossil fuels and environment

Evaluating combined impact of all pollutants from a refinery use of waste reduction (WAR) algorithm

360 The imposed specific standard limits for the individual pollutant emission concentration and the rate of discharge do not consider the combined effect of all the pollutants. The WAR (waste reduction) algorithm provides a methodology for evaluating the environmental impact combining the effects of all pollutants to a PEI (potential environmental impact) score. Such a combined score has the following advantages. (1) It is useful in comparing the environmental effect of same or different types of industries. (2) It can clearly identify the environmental impact generation from different parts of an industry, i.e., it can determine the environmental friendliness of process. (3) It can also be used to optimize design configuration of new plants and also for optimizing operations of existing plants to minimize environmental effects. (4) It can be used as a yardstick by the pollution control authority. In this paper a petroleum refinery is discussed as a case study. The combined effect of seven major pollutants like SO_2, NO_x, CO_2, VOCs (volatile organic compounds), phenols, sulphides, and oil and grease are considered for the potential environmental impact estimation. The PEI due to gaseous pollutants in a real refinery is found to be around 99.95% of the total. The contribution is primarily from SO_2 and NO_x in refinery gaseous effluent and in the category of acidification potential. Such a PEI score represents the potential environmental deterioration considering all the pollutants and all types of impacts. This unique score may be set as a benchmark by the regulatory bodies for the limit value of pollution by any industry. This numerical PEI value can be used for comparison between different industries and can be used for improving environmental friendliness of processes. It can also be related quantitatively with the economics of the manufacturing process or with operating conditions of the industry. (1 figure, 3 tables, 20 references)

Koshti M, Dutta A, and Ray S. 2002
Indian Chemical Engineers, Section A 44(1): 13-18

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Renewable energy and environment

Energy and environmental correlation for renewable energy systems in India

361 The analysis presented in this paper allows the policy-makers to access two important aspects, namely the energy payback period and the environmental friendliness in terms of two important parameters: the EYR (energy yield ratio) and the emission coefficient. In this paper, the authors have calculated the cumulative energy demand and cumulative greenhouse effect for three renewable energy technologies, namely, wind energy, SPV (solar photovoltaic), and SWH (solar water heating) systems, corresponding to typical climatic conditions in India. The life cycle assessment of these systems 1.5 MW, 35Wp, 2 m^2 and 100 litres respectively, has yielded the parameters EYR and emission coefficient. The EYR for these three technologies are found to be from 9.59 to 31.11, 0.58 to 0.91, and 2.32 to 7.14 respectively. Variation of emission coefficients is from 2.40-7.86, 83.72-133.10, and 19.88-61.06 kg CO_2 per GJ delivered from the three technologies respectively. The two parameters have been expressed in the form of the algebraic expression $Y = CX^K$, where $C = 103\ 727$ and $K = 0.9652$ for all the three renewable

Mathur J, Bansal N K, and Wagner H-J. 2002
Energy Sources 24(1): 19-26

energy technologies considered in this paper. The correlation can be used to estimate one parameter if another parameter is known for any power producing system. (1 figure, 14 references)

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Industrial pollution

Physico-chemical treatment for waste water from cluster of small-scale cotton textile industries

362

It has been very difficult for small-scale industries to own individual waste water treatment facility due to non-availability of land and skilled manpower for operation and maintenance of waste water treatment plants. Therefore, a centralized waste water treatment facility for such clusters of small-scale industries is gaining popularity in recent years. This treatment facility is primarily based on the physico-chemical and the biological processes. Biological waste water treatment processes involved several operational and maintenance problems. Physico-chemical treatment methods have great potential to remove colour and low-density solids from waste water and can be implemented because of ease and simplicity of operations. The combined waste water effluent from small-scale cotton textile processing units is highly alkaline and coloured with moderate BOD and COD levels of 190–220 and 700–800 mg/litre respectively. This paper presents the development of physico-chemical treatment, which includes chemical coagulation, dual media filtration, adsorption through activated carbon followed by chemical treatment. The treated effluent had a COD level of 230–240 mg/litre, BOD level of 18–24 mg/litre and 60–65 Pt-Co units of colour. The treated waste water quality after this option conforms effluent discharge standards prescribed by the Ministry of Environment and Forests and state pollution control boards for discharge into inland surface water. (4 figures, 10 tables, 22 references)

Pathe P P, Biswas A K, and Kaul S N. 2001
Indian Journal of Environmental Protection
21(7): 577-587

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India

Removal of colour from effluent of petrochemical industry by fly ash and other agents

363

Use of fly ash for removal of colour from the effluent of a petrochemical industry and optimization of process variables were reported earlier. Further studies in same direction were conducted on various frontiers to reap the benefit of the process of colour removal by fly ash on a large scale. Among the different particle size fractions of fly ash, an intermittent fraction of 150–250 exhibited the highest colour removal efficiency due to high proportion of carbonaceous material and lower proportion of silica. Apart from reduction in colour, treatment of waste water with five per cent fly ash also resulted in the reduction of suspended solids, ammonical nitrogen, COD, and nitrophenol from effluent with no detrimental effect on effluent chemistry. Keeping the variables constant, the efficiency of fly ash and other adsorbents for reducing colour and COD of effluent was found in the order: powder activated charcoal > carbon soot > granular activated carbon > fly ash. The fly ash could reduce the colour of effluent in batch mode (jar test conditions) as well as continuos mode (passing through filter bed). Restriction of flow rate was encountered in the filter bed system. (2 figures, 7 tables, 15 references)

Kapadia M J, Farasram R P, Desai D H,
Bhatt M M. 2001
Indian Journal of Environmental Protection
21(7): 588-595

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A statistical model between traffic volume and noise levels in urban areas

364

The CPCB has notified the ambient air quality standards in respect of noise. When noise levels exceed the permissible limits, it leads to auditory and non-auditory effects. A small stretch of the Bangalore city within the Bangalore City Corporation limits was chosen for the study. A preliminary survey was done to choose the sampling stations. With the help of a sound level meter at each station, readings were recorded for 15 minutes. Simultaneously, vehicle count was done for 2-wheelers, 3-wheelers, 4-wheeler light motor vehicles, and 4-wheeler heavy motor vehicles. After collection of data in the fields, equivalent vehicle counts were estimated and the values were entered in a statistical package and multiple regression analysis was done. It was observed that the average or minimum value of the noise levels in the entire stretch was above the permissible limits. It was also noticed that maximum equivalent noise level at a sampling station (Mekhri Circle) was due to high traffic intensity and heavily loaded trucks. However, the minimum equivalent noise level at the G K V K campus was due to heavy tree plantations. The survey suggests that (1) planting trees on either sides of the road can reduce noise pollution, (2) by maintaining the road conditions and vehicles properly noise levels could be reduced, and (3) reducing noise levels could reduce occupational hazard to traffic police and vehicle drivers. (3 tables)

Murthy U N. 2001
Indian Journal of Environmental Protection 21(9): 837-838

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Increased environmental problems caused due to road traffic noise nuisance in Hyderabad city

365

Road traffic noise pollution is a major cause of unrest and tension among the dwellers living along the roadsides all over the world, especially in urban areas. In Hyderabad city in Pakistan, due to dramatic increase in traffic density on the roads, traffic noise levels have gone much beyond the comfortable limits. Roadside dwellers and traders are constantly exposed to high-level traffic noise for long period. In order to make a detailed assessment of the prevailing traffic noise in the Hyderabad city, this survey was conducted and traffic noise data was collected at five different sites. The collected data has been analysed for average background (L_{90}), average (L_{50}), and average peak (L_{10}) values and results are discussed with reference to recognized international criteria for community annoyance and existing legislation in Pakistan. The results of survey show that the traffic noise levels in Hyderabad city are alarmingly high. The noise level reaches 99 dB(A) peak and LAeq at 87.81 dB(A), which are much above the comfortable limits according to ISO and other national standards. Hence, proper control measures are required. (5 figures, 3 tables, 12 references)

Memon Z-u-D, Ansari A K, and Soomro W B. 2001
Journal of Energy & Applied Science 20(2): 1-7

Department of Mechanical Engineering, Quaid-e-Awam University of Engineering, Science and Technology, Nawabshah, Pakistan

Vertical dispersion of gaseous pollutants in ambient air

366

Vertical gradient of gaseous pollutants, namely NO_2 and SO_2 has been studied in this work. In this study measurements of NO_2 and SO_2 have been done at various heights of the northern portion of the eight-storeyed Civil Engineering Building at the Jadavpur University in Kolkata, India. The main source of pollution is the north-south oriented Raja S C Mallick Road of

Kolkata. The sampling work was done by high volume sampler. Four high volume samplers were placed at different places of the building. Wind velocity and wind direction were also measured at the rooftop of an adjacent four-storeyed building. The wind velocity was measured on different monitoring day by a cup anemometer and wind direction was recorded by wind vane. Temperature was also recorded on every monitoring day at the fifth landing of the Civil Engineering Building by an ordinary mercurial thermometer. Analysis of NO_2 was done by Jacobs-Hochhiser method (arsenite modification) and that of SO_2 by West and Gaeke method, using an UV Shimadzu Spectrophotometer. Two model equations were developed using Grapher Software. Based on this study it has been tentatively concluded that concentration of each of these pollutants decreases with increasing altitude and logarithmic equations are best fit for both NO_2 and SO_2. (6, figures, 6 tables, 3 references)

Misra A K, Chakrabarty S N, Debsarkar A, Das K A. 2001
Indian Journal of Environmental Protection
21(8): 734-739

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Jadavpur University, Kolkata - 700 032, India

Lead content of petrol and diesel and its assessment in an urban environment

367 Pakistan is one of the few countries in Asia that continues to use only leaded-petrol as vehicular fuel. The concentration of lead in its petrol reported in 1991 was 1.5–2.0 g Pb/L (lead per litre), which far exceeded the WHO's guideline of 0.15 g Pb/L. The authors have undertaken this study to trace and quantify this toxic element in the environs of Karachi, Pakistan's major metropolis, having more than 30% of the nation's total number of vehicles. In this article the authors report the Pb contents of petrol and diesel currently manufactured and marketed in the city. The samples of regular petrol collected in 1999 were found to contain 0.363 g Pb/L (range: 0.335–0.390 g Pb/L), a factor of 5 lower than that marketed prior to 1991. Its concentration in diesel fuel was much lower (0.017 g Pb/L). Based on the available statistical data on the type and volume of vehicular traffic, it was assessed that the current lead emission from vehicular traffic into the atmosphere is 391 metric tonnes a year, which is a factor of 2.7 lower than that estimated for 1999. The atmospheric Pb burden from vehicular traffic is enormous (391 tonnes/year) and continues to be a serious environmental threat. The situation calls for introduction of unleaded petrol in the market. The refineries should manufacture and market unleaded petrol and continue the efforts to phase out leaded petrol in future. (1 figure, 2 tables, 10 references)

Parekh P P, Khwaja H A, Khan A R, Naqvi R R, Malik A, Khan K, Hussain G. 2002
Environmental Monitoring and Assessment
74(3): 255-262

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Hazardous wastes

Assessment of waste effluents from drug industry and its influence on solid quality

368 The discharges from drug industries have adverse effect on water bodies and solid waste pollutes land. A case study was designed to understand the impact of wastes generated from bulk drug industries on clean environment. The physico-chemical characteristics of the effluents from M/s Godavari Drug Industry from the Nanded district of Maharashtra, was analysed. Rapid EIA (environment impact assessment) studies were planned for the year 1997/98 to characterize the liquid waste from the industry and its effect on the nearby agricultural land. The aim was

also to focus on evaluation of the impact and then delineate the environmental management planning to minimize the adverse impacts. The waste effluent generated during various manufacturing process of bulk drug was characterized for different water quality parameter. The toxic effect of waste effluent was evaluated with respect to soil quality. SAR value of the soil was very high and cannot be recommended for any agricultural use. The soil characteristics at the site were also determined. The industrial effluents affect the soil and inhibit the crop growth. The higher amount of salts and high concentration of alkali metal in the waste effluents increases the salinity and ESP (exchangeable sodium percentage) of the soil to the harmful level of phytotoxicity. The soil productivity is also deceased due to reduced nutrients. The higher COD value also indicates the harmful nature of effluents for soil structure. The adverse effects of pollution due to waste effluents on soil profile properties were observed to be more severe in the profiles located nearer to the drain as compared to those away from the industry. It suggests the need to reclaim, such polluted soil using fertilizers and other technologies. An integrated approach, taking into consideration, the quality of the effluents, growth of the drug industry, and its location along with the establishment of the ETP (effluent treatment plant) is likely to mitigate the potential problems considerably. (3 figures, 9 references)

Bachewar M S and Mehta B H. 2001
Indian Journal of Environmental Protection
21(9): 834-836

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Heavy metal pollution in the Visakhapatnam harbour waters, East coast of India (Bay of Bengal)

369 Study of heavy metal distribution in plankton of the sea water has gained importance with the increasing awareness of the danger of marine pollution. Visakhapatnam harbour receives most of the effluents through a rain-fed stream of Megadrigedda from the large- and small-scale industries situated in the vicinity of the harbour area. It also receives the city's main domestic sewage. The present paper incorporates the results of investigation on distribution of heavy metal in Zooplankton and sea water and their seasonal variations. Zooplankton and sea water samples were collected from the inner and outer harbour waters once a month for a period of one year and were estimated for Cd, Cu, Ni, Pb, and Zn by using the standard atomic absorption technique. Analysis of these metals in water samples was carried out following APDC-MIBK pre-concentration procedure and final quantification was made by atomic absorption technique. Salinity of the sea water was measured by using the standard technique of silver nitrate titration method. The salinity of the harbour waters varied from 22.62% to 33.64%. However, high concentrations of dissolved and zooplanktonic metals were observed at inner harbour waters than that of outer harbour waters. The variation of these metal concentrations indicated a decreasing trend from the inner harbour to outer harbour zone where these metal concentrations were diluted with the coastal water of the Bay of Bengal. The concentrations of Cd, Cu, Pb, and Zn in water and Zooplankton showed a distinct seasonal variation with higher values during monsoon (July–November) and lower values during pre-monsoon (March–June) periods. The higher concentrations observed during the monsoon period could be attributed to the combined effect of fresh water influx

with land derived materials along with metal rich industrial effluents and domestic sewage entering into the inner harbour waters. The high concentrations of metals in water and zooplankton observed at the inner harbour might be due to its proximity to the discharge of metal-rich industrial effluents along with domestic sewage compared to outer harbour waters. The enrichment of metals in water and zooplankton of the harbour waters are in the order of Zn > Cu > Pb > Cd> Ni. The concentration factors of the metals, calculated from the metal concentration of the plankton, is divided by the metal concentration of the ambient medium. The concentration factors of these metals in the harbour water were in the order of Ni > Cd > Pb > Zn at outer harbour, while in the inner harbour the order is Cd > Pb > Cu > Zn> Ni. Overall, the concentration factors in the present study were lower when compared with the reported values for Zooplankton in the Bay of Bengal. From these results, it is evident that the harbour waters are being polluted by the industrial effluents and the city's domestic sewage discharged into the harbour waters coupled with sluggish circulation – due to inadequate tidal flushing – turn the harbour waters highly polluted. (2 figures, 4 tables, 23 references)

Rao I N, Krupanidhi G, and Kumari R R. 2001
Indian Journal of Environmental Protection
21(9): 825-830

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Metabolism and toxicity of arsenic: a human carcinogen

370 Inorganic arsenic is considered as the most potential human carcinogen, and human beings are exposed to it from soil, water, air, and food. In the process of arsenic metabolism, inorganic arsenic is methylated to monomethylarsenic acid and finally to dimethylarsinic acid, followed by excretion through urine. Thus, arsenic exposure may cause DNA hypomethylation due to continuous methyl depletion, facilitating aberrant gene expression that results in carcinogenesis. Further, though arsenic is nonmutagenic, it interacts synergistically with genotoxic agents in the production of mutations, and also induces chromosome abnormalities and cell proliferation. Few epidemiological investigations in the arsenic endemic regions of West Bengal (India) have established that inorganic arsenicals have the potential to cause skin and lung cancers in humans. Studies on the genetic polymorphism in the arsenic methyltransferase(s) with the population exposed to arsenic, and characterization in the arsenic-induced mutational spectra may be useful for the development of molecular markers and therapeutics and for furthering the knowledge of arsenic-induced carcinogenesis. (2 figures, 86 references)

Roy P and Saha A. 2002
Current Science 82(1): 38-45

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700 054, India <prodosh@boseinst.ernet.in>

Nature of arsenic pollutants in groundwater of Bengal basin—a case study from Baruipur area, West Bengal, India

371 High incidence of arsenic in groundwater occurs as several small patches surrounded by zones with low arsenic in vast areas of West Bengal, India and adjoining Bangladesh. From the low- and high-arsenic groundwater zones, subsurface sediments have been analysed for mineral and chemical variations, in Baruipur, the worst arsenic-affected area in West Bengal. The Holocene sedimentary succession, in this part of Gangetic alluvium, shows a fining-upward sequence from medium to fine sand, silt, and finally to clay with occasional peat layer. The clay layer (As = 2–31 mg/kg) and peat layer (As = 9–40 mg/kg) contain higher

concentration of arsenic compared to the silt layer (As = 2–6 mg/kg) and the sand layer (As = 1–7 mg/kg). It is inferred that the arsenic contamination in groundwater is related more with the components of sandy layer than others. Within the sandy layer, the components like (1) coated iron oxyhydroxides with residual magnetite and ilmenite, (2) illite, (3) iron hydroxide-coated sand grains, (4) chlorite, (5) biotite, and (6) siderite concretions store most of the arsenic and are identified as the arsenic pollutants for groundwater in this part of Bengal basin. Arsenic is introduced into the aquifer sediments in soluble state and get adsorbed on iron-rich clastic grains and on authigenic siderite concentrations. Adsorption of the element on the sites and its consequent desorption to the groundwater are interpreted to be controlled by microbial activity in the aquifer sediments. (12 figures, 2 tables, 15 references)

Pal T, Mukherjee P K, and Sengupta S. 2002
Current Science 82(5): 554-561

Central Petrological Laboratory, Geological
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World scenario of particulate matter, NO_2 and SO_2— a review

372 With the increase in urbanization and industrialization, air pollution poses a serious problem all over the world. Pollutant concentrations exceed the safety limits prescribed by the WHO (World Health Organization) by large margins. The situation is alarming in many countries due to lack of or insufficient implementation of preventive environmental management strategies. Air pollution not only affects human beings leading to serious health problems, but it also affects plants and animals, thus disturbing the entire ecological balance. A review of the literature from 1990–98 on major air pollutants such as particulate matter (SPM, PM_{10}, and PM_{25}), SO_2, and NO_2 in both the developed and the developing countries has been presented in this paper. The review revealed that industrialization and automobile traffic in and around the cities have resulted in severe air pollution, threatening the health of urban population. Urban air quality management strategy is urgently required to design and implement plans to restore the air quality in metropolitan cities. The database for ambient PM_{10} and PM_{25} are not adequate for major Indian cities as well as South-east Asian cities. National ambient air quality standards for such cities need to be prescribed and implemented. Equally, stringent emissions need to be enforced for mitigation of air pollution. In addition, raising of public awareness and education regarding health impact due to polluted air will play an important role in controlling the pollution levels. It is also advocated to develop the green belt in the polluted regions of the cities as one of the control measures.
(3 tables, 40 references)

Gurtu D, Vaidya M, and Gajghate D G. 2001
Indian Journal of Environmental Protection
21(8): 683-695

Air Pollution Control Division, National
Environmental Engineering Research Institute,
Nehru Marg, Nagpur - 440 020, India

Impact of Deepavali fireworks on air quality and noise levels in Tiruchirappalli

373 Air samples were collected and noise levels were measured at four different residential places in Tiruchirappalli to determine the impact of Diwali (Deepavali) fireworks on ambient air quality and noise environment. The air quality and noise level on the day of Diwali was compared with the air quality and noise levels observed before and after Diwali. It has been found that there was considerable increase in SPM concentration due to Diwali fireworks. The results also reveal that even on normal

Ravichandran C, Chandrasekaran G E,
Shalini V, Venkatasubramanian R. 2001
Indian Journal of Environmental Protection
21(8): 677-682

days, noise levels exceeded the permissible limits at all places. Allotment of special places for firing the fireworks will help people in residential areas and sensitive areas from exposure to high noise and air pollution levels on special occasions, like Diwali. (5 tables, 3 references)

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Global environmental issues

Large point source (LPS) emissions from India: regional and sectoral analysis

374

Indian LPSs (large point sources) contribute to CO_2 and SO_2 emissions to a large extent (above 65%) and to CH_4, N_2O, and No$_x$ emissions to some extent (around 10%). The former emissions are primarily from fossil fuel combustion while the latter have agriculture sector dominance, explaining the drastic difference in LPS contributions to all India emissions. The present paper covers 509 LPSs for India. These are well distributed across the country. However, there are some regions of very few LPSs (like the western desert and the hilly areas of north, northeast, and coastal west) and some regions of high LPSs (like Mumbai–Ahmedabad corridor, Delhi, and near coalmine mouths). There is a dominance of power plants in Indian LPS emissions for CO_2 and SO_2 (47% each), with cement plants (9% and 5%), and steel plants (6% and 7%) being the other major contributors. Moreover, due to the growing population, increasing urbanization, and higher consumption levels, these LPS emissions are growing much faster than the national average. The present analysis is useful for policy-making to mitigate these pollutants and their associated impacts. The results demonstrate that LPSs are responsible for considerable part of the Indian emissions. It is estimated that in 1995, the 100 largest LPSs alone emitted more than 440 Tg CO_2 (57% of national CO_2 emissions), 2.73 Tg SO_2 (59%), 1.74 Tg CH_4 (9.4%), 14 Gg N_2O (5.6%) and 0.4 Tg NO_x (12%). The authors have concluded that air pollution control in India is not as horrendous as it appears. Concentration on 70 LPSs can tackle more than 50% of SO_2 and CO_2 emissions. The authors have indicated that initially mitigation efforts should be concentrated in 50 power plants, 5 steel plants, and 15 cement plants initially. (9 figures, 11 tables, 27 references)

Garg A, Kapshe M, Shukla P R, Ghosh D. 2002
Atmospheric Environment 36(2): 213-224

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Effect of acid rain on some useful plants

375

Acid rain is a worldwide environmental problem and the increasing acidity in soils and natural waters causes serious environmental damage. Acid rain has become an invisible threat. The present study highlights the adverse effects caused by acid rain on plants and soils as a whole. Acid rain is in fact a mixture of sulphuric acid (H_2SO_4) and nitric acid (HNO_3), where the ratio of these two may vary depending upon the relative quantities of the oxides of sulphur and nitrogen emitted. In order to assess the damage the acid rain has on plants, experiments were performed to determine the change in growth and morphology after exposure to simulated acid rain of pH 2, 4, and 5. The effects of the simulated acid rain on a variety of other experimental parameters were determined to understand the behaviour of plant response to this experimental stress. The results showed that the lower the pH, the greater the chances of plant damage. Plants exposed to pH 5 did not manifest any distinct injury symptoms. In general, the plants showed reduced foliar size and decreased vigour and the acid rain had an adverse impact on the growth and development of the plants. (2 tables, 7 references)

Siddiqui A N and Shukla R N. 2002
Environmental Pollution Control Journal 5(3): 42-47
School of Environment Biology,
APS University, Rewa, India

Bio-energy and climate change – opportunities in India

376 With the scientific community's endorsement of the view that the GHG-induced (greenhouse-gas-induced) global warming is associated with the energy consumption based on fossil fuels, the environmental issues related to energy become all the more important. Further, the national trends in the energy sector indicate a huge demand–supply gap and a visible dependence on energy imports, particularly petroleum products. Bio-energy potentially addresses the twin challenges arising out of fossil-fuel-based energy consumption—the energy shortages and environmental sustainability. Modern biomass conversion technologies include the conversion of biomass to modern energy forms, such as electricity or gaseous (biogas and producer gas), liquid (ethanol and methanol), and solid (briquette) fuels. This article attempts to highlight the environmental implications of fossil-fuel-based energy consumption and traditional biomass uses, and assesses the potential of the modern bio-energy technologies for mitigating climate change and providing auxiliary energy sources. The authors highlight that the reliance on biomass energy is not likely to change in the near future. With the advent of modern bio-energy technologies, the dependence may only increase with increased consumption of biomass for energy use. Given the large market potential for these technologies in India and the emerging carbon markets, it is imperative to facilitate the implementation of bio-energy projects through the removal of the already-identified barriers to the promotion of these technologies and to devise appropriate policies, guidelines, and procedures in the light of these new opportunities. (3 tables, 8 references)

Rao K U and Ramana P V. 2001
Bio Energy News 5(4): 15-19

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New Delhi - 110 003, India

Environmental benefits on a life-cycle basis of using bagasse-derived ethanol as a gasoline oxygenate in India

377 Bagasse is the fibrous residue generated during sugar production and can be desirable feedstock for the production of ethanol, to be used as fuel. The bagasse left after satisfying the mills' energy requirements can be used in a bio-conversion process to make ethanol. An LCA (life-cycle assessment) was conducted to quantify the environmental benefits of diverting excess bagasse to ethanol production as opposed to disposing it through the current practice of open-field burning. The LCA results demonstrated lower net values of the ethanol scenario for carbon monoxide, hydrocarbons (except methane), SO_x, NO_x, particulates, carbon dioxide, methane, and fossil fuel energy consumption. The reduced carbon dioxide and methane emissions for the ethanol scenario also lower its greenhouse potential. The additional drivers are the lower values observed for the depletion of natural resources, the air acidification potential, the eutrophication potential, the human toxicity potential, and the air odour potential, which are the impact assessment categories for the ethanol scenario. Specifically, the deployment of the bio-ethanol option, due to its significantly lower greenhouse

Kadam K L. 2002
Energy Policy 30(5): 371-384

potential, can be facilitated via the clean development mechanism, as specified under the Kyoto Protocol. (4 figures, 7 tables, 32 references)

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Health effects

Body fluoride status of populations with fluorosis in 2 mandals of Anantapur district

378 Fluorosis is a serious health problem caused by the ingestion of fluoride in excess through water, food and air. Based on a number of field studies, endemic fluorosis is now recognized as a public health problem in several Indian states. The objectives of the study were to assess the prevalence of dental and skeletal fluorosis in the populations and to assess the fluoride status of the selected subjects. The study undertaken in the Rapthadu and Kuderu mandals of Ananthapur district with two different water fluorine-ion levels showed high prevalence rate in the former, which had higher water fluorine-ion and food fluorine-ion levels compared to the latter. These levels corresponded to the total fluorine-ion intake and the serum fluorine-ion and urinary fluorine-ion levels. Positive correlations were found between the fluorine-ion intake and the prevalence of dental and skeletal fluorosis; the fluorine-ion intake and the serum fluorine-ion levels; the fluorine-ion intake and urinary fluorine-ion levels. The body sodium and potassium levels were found to be within the normal ranges for all the subjects. However, the serum calcium levels were lower than the normal limit and decreased with increased serum fluorine-ion levels. (8 tables, 11 references)

Devaki P B and Ramalakshmi T. 2001
Indian Journal of Environmental Protection
21(9): 797-802

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Fluoride toxicity in ground waters of Chittoor district

379 In India fluorosis has been detected in several areas in the states of Andhra Pradesh, Haryana, Karnataka, Madhya Pradesh, Maharashtra, Rajasthan, Tamil Nadu, and Uttar Pradesh. Chittoor is one of the worst hit districts. A favourable natural environment and abundant fluorine sources are important reasons behind the high fluorine content in the ground water. Lithologically, a great majority of the intrusive rocks are granites, which occupy 90% of Chittoor. The granites are rich in fluorine minerals and, thus, are the source of fluorine for the enrichment and concentration of the fluorine content in the groundwater. Fluorosis has been identified in about 140 villages in Chittoor. The shallow groundwater zones from the soft and hard rock formations show high incidence of fluoride concentration. The fluoride concentration ranged between 0.6 ppm (parts per million) and 15 ppm. Among the villages affected by fluorosis, the fluoride concentration was less than 1 ppm in 40 villages, between 1.5–3.0 ppm in 84 villages, and greater than 3.0 ppm in 16 villages. The excessive alkalinity may be responsible for the high incidence of fluoride in the water. Granite is extensively distributed in the high-fluoride-bearing groundwater of the study area. The authors highlight that due to the high concentration of fluorine in the groundwater, general public interest and concern has been initiated over its harmful effects to human health. The problem of high fluoride concentration in groundwater has to be tackled on war footing. There is an immediate need to defluoridize the water system either by community or by domestic defluoridation techniques or filers. The

Rao S V L. 2001
Indian Journal of Environmental Protection
21(9): 794-796

government should apply firm rules for the utilization of groundwater so that the use of tube wells and hand pumps in fluoride zones could be discouraged. (1 figure, 2 tables, 4 references)

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Control technologies

Arsenic contamination in groundwater affecting major parts of southern West Bengal and parts of western Chhattisgarh: source and mobilization process

380 The arsenic contamination problem in West Bengal and Chhattisgarh is a natural phenomenon. The main sources of arsenic in the latter are the weathered acid magmatic rocks of the Dongargarh rift belt and not the locally present sulphides. In West Bengal, arsenic sorbed in Fe-oxyhydroxide was preferentially captured in argillaceous, organic-rich, mid-Holocene deltaic sediment. The arsenic concentrations are neither high nor very different between adjacently located polluted or unpolluted aquifers. The arsenic is released to the groundwater in both cases by bio-meditated reductive dissolution of Fe-oxyhydroxide. In West Bengal, continued and increased recharging of shallow aquifers because of extensive pumping triggered the reduction process. The process of enhanced recharging of shallow aquifers, because of extensive groundwater abstraction, would enforce the movement of groundwater. This, in turn, would mobilize the strongly-reducing degraded organic products enriched in groundwater through the Fe-oxyhydroxide-bearing sediment, enhancing reduction and release of sorbed arsenic to groundwater. The natural process of release of the arsenic to the groundwater can also be microbially activated to remove the arsenic by inducing the precipitation of iron-sulphide that would also absorb the co-precipitated arsenic and, thereby, clean the groundwater. *In situ* bio-remediation is an emerging technology that can be a low-cost alternative to standard 'pump-and-treat' processes for cleaning up the contaminated groundwater. (6 figures, 39 references)

Acharyya S K. 2002
Current Science 82(6): 740-744

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Upgrading a paper industry effluent treatment plant for capacity expansion with resource to recycling effluent

381 This article addresses the upgradation of an ETP to meet the capacity expansion of a large-scale paper industry for recycling of treated effluent. The performance evaluation of the plant under the existing operating conditions and measures delineated for the effective performance of the plant is also reported. The performance evaluation of the ETP indicates that the various unit processes and operations, under the existing operating conditions, did not function at the optimum level of performance, as per its design. This is attributed mainly to the poor operation and maintenance of the plant. The performance of the ETP, with the present waste water flow and characteristics, could be improved by optimizing the operating parameters in the individual units. The equalization and neutralization of the waste water and a build-up of the active biomass in the activated sludge system maintaining the design F/M ratio will effectively treat the combined waste water, improving the performance of the plant. In addition, proper maintenance of the primary and secondary classifiers will also achieve optimum performance of the ETP. A viable treatment alternative based on treatability

studies is recommended for upgrading the existing facility for the additional waste water load from the capacity expansion. The treatment alternative intends to provide effluent, which meets the requirements for recycling in the paper machine section, through modification and proposed additional units. The implementation of the proposed scheme will result in the conservation of 28 500 m^3/day of freshwater demand. (2 figures, 12 tables, 5 references)

Nandy T, Kaul S N, and Shastry S. 2002
Resources, Conservation and Recycling
34(3): 209-228

National Environmental Engineering Research
Institute, Nehru Marg, Nagpur - 440 020,
India

Energy from municipal waste: an overview with special reference to India

382 The management of MSW (municipal solid waste) is a major problem in Indian cities. Improper disposal of garbage leads to the degradation of the environment and poses health hazards to the public. However, if energy can be generated during the safe and scientific disposal of waste, this can be a great advantage. A number of technologies for generating energy from waste are now available. Considering the importance of converting waste to energy, the Government of India has given high priority to setting up waste-to-energy projects. This paper highlights the status of the latest technologies for obtaining energy from waste. While very encouraging progress have been made in the country during last few years in implementing waste-to-energy projects using different industrial waste, the achievement in the urban sector is rather discouraging. Some major setbacks to the government programmes include (1) the high capital cost of such projects, (2) the risk factor involved due to the lack of success stories, (3) the deficiency in legislating, (4) the lack of suitable foreign and indigenous technologies, (5) the lack of financial sources for urban local bodies and state governments, and (6) the absence of long-term strategies at the state levels. The author points out that the future of waste-to-energy projects will depend on the setting up and successful operation of a few projects using MSW as well as the creation of a long-term strategy to increase general awareness. (2 tables, 4 references)

Sarma P C. 2001
Bio Energy News 5(2): 11-14

Inspectorate of Electricity, Government of
Assam, Guwahati, India

Energy from cotton dust

383 The technological options for the utilization of cotton dust at the Indian spinning mills are (1) generating biogas as an additional source of energy and manure and (2) converting to biomanure by incorporating certain natural recycling larva/grubs. The laboratory studies have shown that one kilogram of micro dust could generate about 200 litres of biogas in 50 days. It is advantageous for the mills to use their non-saleable waste like cotton dust, which is in perennial supply, for biogas generation at their premises itself. However, handling solid waste like micro dust for biogas generation, unlike cow-dung used for the production of gobar gas, necessitates modifications in the type and design of the digester. This article describes the work carried out on the generation of biogas from cotton dust and this work could be utilized for disposing the polluting cotton-dust through biological methods. The dust samples from the mills were analysed for metallic elements such as potassium, sodium, copper, iron, aluminum, and manganese. The results show that micro dust in the country can generate fuel equivalent to 3 million litres of petrol or 1.82 million kg of liquefied petroleum gas.

The batch-process fermentation plant is ideal for obtaining the maximum amount of biogas. The mills can generate biogas through fermentation, which can be utilized for the mills' in-house consumption. The spinning mills are in an advantageous position to be able to utilize the biogas that can be produced in their premises by making good use of their solid and voluminous micro dust, which would otherwise pose a problem of pollution. (1 figure, 3 tables, 3 references)

Zacharia J and Krishnan P P. 2001
Bio Energy News 5(2): 20-22

Bombay Textile Research Association,
Mumbai - 400 086, India

Air pollution caused by opencast mining and its abatement measures in India

384 Opencast mining dominates coal production in India. A survey was conducted to evaluate its local atmospheric impact. Emissions data were utilized to compute dust generation due to different mining activities. Work zone air quality, ambient air quality, and seasonal variations are described revealing high pollution potential due to SPM and consequent impact on human health. Air pollution control measures involve planning and implementing a series of preventive and suppressive measures in addition to dust extraction systems. Different abatement measures are enumerated. Pollution control by trees, the tolerance of trees to different air pollutants and plant species useful for controlling pollution are also discussed. There is a need for wider application of dust control chemicals on haul roads. Sustainable management of pollution can be achieved by the proper implementation of suggested abatement measures. (8 figures, 4 tables, 18 references)

Ghose M K and Majee S R. 2001
Journal of Environmental Management 63(2): 193-202

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of Mines, Dhanbad - 826 004, India
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Removal of organic matter from dairy industry waste water using low-cost adsorbents

385 The present study envisages the use of cost-effective adsorbents such as fly ash, bagasse, wheat straw dust, sawdust and coconut coir for the reduction of TDS (total dissolved solids) from dairy industry effluent waste water by adsorption process. PAC (powdered activated carbon) was also used to compare the results. Raw sorbent materials were treated for delignification prior to their use. Effect of pH, contact time, adsorbent dose, initial concentration of adsorbate, i.e., TDS, adsorbent particle size, were also evaluated. PAC was effective at pH 4, whereas the other five low-cost adsorbents at pH 6 and at pH 8 increase in contact time, absorbent dose, low adsorbate concentration, and smaller particle sizes were effective in the removal of TDS. Sorption data have been correlated with both Langmuir and Freundlich adsorption isotherm models. Freundlich static isotherm model is found applicable for all the six adsorbents to remove TDS from the dairy waste water. The order of selectivity is PAC, bagasse, fly ash, sawdust, wheat straw dust, and coconut coir for the removal of TDS at optimum conditions. (6 figures, 3 tables, 8 references)

Rao M and Bhole A G. 2002
Indian Chemical Engineers, Section A 44(1): 25-28

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Engineering, Badnera - 444 701, India

Anaerobic degradation of BTX-compounds such as benzene and toluene

386 Aerobic biodegradation technology of BTX-aromatic compounds such as benzene, toluene, benzoic acid, etc. have already been applied in the field. However, only little is known about the fate of such chemicals under the anaerobic environment over a period of time. Further aerobic treatment is costly and not a

foolproof technology. Although anaerobic treatment is slower than the aerobic one, it has certain advantages. It is also now evident that certain microbes can degrade the BTX-aromatic compounds under anaerobic conditions. There is a recent trend to degrade these compounds anaerobically. But handling of such chemicals anaerobically needs some special knowledge of microbiology, anaerobiosis, bio-kinetics, toxic-inhibitions, and other design parameters. The present paper deals with such basic aspects for the anaerobic degradation of BTX-compounds, particularly with benzene and toluene, which is based on literature survey as well as experimental data from research work for the anaerobic treatment of benzene and toluene. In the present juncture, anaerobic degradation of aromatic compounds is not very successful from the techno-economic point of view, but it has importance for public health and recovery of renewable energy-resources. If the technological gaps are overcome, then anaerobic technology shall play a key-role in future for the treatment of waste waters containing such aromatic compounds. (3 figures, 3 tables, 33 references)

Chaudhuri B K. 2002
Indian Chemical Engineers, Section A 44(1): 19-23

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Biological evaluation of chromium sludge from tanning waste

387 Chromium in trivalent state is not harmful and can be extracted from leather industrial waste. During separation/extraction of proteins from tanned leather waste by enzyme-alkali treatment, chromium sludge is generated, commonly termed as chrome sludge, which needs further treatment. The aim of the work reported here is to get protein-free chromium from chrome sludge by biological treatment, especially by applying anaerobic digestion technology, which requires less energy and investment. The effect of anaerobic digestion on chrome sludge was observed using different fermentation conditions of broth at 50 °C temperature and 15 days of incubation period. The optimum fermentation composition to liberate chromium from the chrome sludge was (sludge:inoculum:water) 3:1:1. After anaerobic digestion, the chromium concentration was increased from 7.94 w/w% to 9.12 w/w%. The presence of chromium along with proteins does not affect the growth and metabolism of mixed anaerobic bacteria, which help to remove chromium from chrome sludge. The authors conclude that (1) chrome sludge could be considered as a potential substrate for anaerobic digestion; (2) anaerobic digestion will be a low cost and environment-friendly technology for the removal of protein from chrome sludge, as biotechnological process requires less energy and less investment; (3) it is advisable to use freshly prepared chrome sludge and active anaerobic bacteria to avail of better performance for the removal of protein biologically; and (4) further studies are recommended before going to a large-scale/industrial application for the removal of proteins from chrome sludge by biological method. (5 figures, 1 table, 15 references)

Saha N, Kresalkova M, Saha L, Kolomaznik K. 2002
Indian Chemical Engineers, Section A 44(1): 3-6

Tomas Bata University in Zlin, Faculty of Technology (Polymer Centre) TGM 275, CZ-76272 Zlin, Czech Republic <nabanita@ft.utb.cz>

Treatment of industrial waste water with solar detoxification technology

388 Although there are various conventional technologies available for the treatment of industrial effluent they are not environmental-friendly, as they consume more power and chemicals. The solar detoxification technology may be the only environmentally benign technology among the rest of all. The solar detoxification is

attractive because it uses the sun's energy, produces no harmful by-products and can destroy up to 99.9999% of the organic contaminates contained in the waste water and contaminated air. The process has the advantages of operation with low power consumption, not emitting any hazardous waste by-products and is simple to operate and maintain over a twenty-year life. The solar detoxification process treats water at room temperature, roughly 20–40 °C. This paper deals with the industrial application of solar detoxification technology in waste water treatment. Solar detoxification has shown great potential for the application of this technology to the treatment of industrial waste water. The solar detoxification can be applied to a number of known environmental problems such as treatment of industrial effluent and air contamination. The treatment scheme suggested in this paper shall be able to treat the effluent effectively. The next logical step is the commercial demonstration of the technology. Although only few commercial demonstrations have been reported to date, it is expected that the demonstration activity will pick up considerably in future. (2 figures, 1 table, 6 references)

Chaubey M. 2002
Environmental Pollution Control Journal 5(3): 36-39

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<mritunjayc@yahoo.co.in>

Utilization of low-cost adsorbents for the removal of heavy metals from waste water—a review

389 In this article, a comparative study for the removal of pollutants from the waste water by adsorption process, using various adsorbents, has been reviewed. The investigators worked on different low cost adsorbents such as rice husk carbon, rice straw, cotton waste, hair, coal, bentonite clay, wood charcoal, bagasse, saw dust, fly ash, blast furnace, flue dust, bark, red mud, agricultural and fertilizer waste materials, etc. The results obtained were compared with the results of commercial activated carbon and presented. Because of the high cost of conventional activated carbon, intensive research was done to identify the low cost adsorbents. The adsorption process studied by many authors for the removal of heavy metals is presented in this paper. The low cost adsorbents are very useful for the treatment of waste water to reduce the concentration of heavy metals instead of the costly activated carbon. The efficiency of non-conventional adsorbents varies between 50%–100% removal, depending on characteristics of adsorbents, concentration of adsorbates, etc. The authors have highlighted that there is scope for more research for the evaluation of the technical data and economic feasibility based on the system of continuous and pilot plant scale studies, so that these low cost adsorbents can be effectively and efficiently used in the effluent treatment. The use of low-cost adsorbents in waste water treatment is recommend since they are relatively cheaper and locally available resulting to relief on transportation cost. These non-conventional adsorbents require simple alkali/acid treatment to increase their efficiency. Once these low cost adsorbents get exhausted it is also possible to regenerate for reuse with simple alkali/acid treatment or burned after dying. (42 references)

Rao M, Parwate A V, and Bhole A G. 2002
Environmental Pollution Control Journal 5(3): 12-22

College of Engineering, Badnera - 444 701, India

Adsorption studies of Cd(II) on polyacrylamide grafted used tea leaves from aqueous solution

390 Water pollution due to toxic heavy metals has been a major cause of concern for chemists and environmental engineers. In

this paper, the adsorption of some heavy metal ions from aqueous solution onto PGUTL (polyacrylamide grafted used tea leaves) has been studied. The effects of variables, such as pH, concentration, and temperature have been investigated. Adsorption isotherms were studied. Some kinetic and thermodynamic parameters have also been investigated. The PGUTL has been prepared as a new adsorbent. Experiments have been conducted to investigate adsorption characteristics for 7 heavy metal ions on PGUTL. The adsorption capacity is found to increase in the order: Ni (II) < MN (III) < CU (II) < Zn (II) < Cd (II) < Hg (II) < Pb (II). Effects of contact time, initial concentration, pH, light metals ions, and temperature have been studied for the removal of Cd (II). The adsorption process was found to follow first order kinetics. The adsorbed Cd (II) was desorbed quantitatively by 0.5 M HCl solution and the adsorbent could be re-used for three cycles consecutively. Adsorption isotherms and thermodynamic parameters were also studied. (9 figures, 4 tables, 24 references)

Singh D K, Garg S K, and Bharadwaj R K. 2001
Indian Journal of Environmental Protection
21(7): 604-610

Department of Chemistry, Harcourt Butler Technological Institute, Kanpur - 208 002, India

Removal of heavy metals from waste water of thermal power station by water hyacinth

391 Water hyacinth (*Eichhornia crassipes*), which infests waterways in considerable sections of the world, has been used for removal of heavy metals, such as copper, lead, cobalt, and zinc from waste water of thermal power stations. It was studied for different concentrations of 1, 10, and 20 mg/L for a time period of 24 hours. Removal efficiency of heavy metals was determined separately for each standard metal solution and waste water of thermal power station. The study revealed that in lower concentrations, the plant growth was normal and removal efficiencies were good. At higher concentrations, the leaves started wilting and removal efficiencies were less. By using water hyacinth, the metal ion concentration from waste water can be reduced to very low levels conforming to the acceptable water quality standards. The authors conclude that water hyacinth can be used for quantitative removal of heavy metals, such as Cu, Pb, Co, and Zn from effluents of thermal power station. (8 tables, 7 references)

Kamble S K and Patil M R. 2001
Indian Journal of Environmental Protection
21(7): 623-626

Department of Chemistry, Institute of Science, Nagpur - 440 001, India

Removal of fluoride from the Salem Steel Plant effluent

392 The SSP (Salem Steel Plant) of the Steel Authority of India Ltd generates effluent containing fluoride from 2 streams of acid pickling unit at the rate of 15 000 to 18 000 litres/hour and 10 000 litres/hour, respectively. By the existing alum and lime treatment, SSP could reduce the fluoride concentration of effluent to 8 ppm only. As per the Tamil Nadu Pollution Control Board, the allowable concentration of fluoride in effluent for discharge is 2 ppm or less. By a method developed by BARC (Bhabha Atomic Research Centre), Mumbai, the concentration of fluoride in the steel plant effluents, could be brought down to 2 ppm by forming a stable, soluble, and harmless complex and also other pollutants were kept within the permissible limits. The complex formed consists of fluoride, calcium, and aluminum. This paper describes the work done and the result obtained in this study. This work confirms that the BARC method of treatment to remove fluoride from water has been successfully applied to the SSP effluent to bring down its fluoride

Saha S and Chandran T J. 2001
Indian Journal of Environmental Protection
21(7): 627-630

concentration along with all other constituents below the permissible limits. The fluoride complex formed in the process is highly stable and does not break even after distillation with concentrated sulphuric acid at 180 °C. (3 tables, 7 references)

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Efficacy of activated carbon for the removal of phenolic derivatives – regeneration of activated carbon

393 By the conventional secondary treatment, phenolic derivatives cannot be removed up to the required permissible limit and needs tertiary adsorption treatment. The use of activated carbon has been considered as the most efficient adsorbent, due to its surface area. However, the high cost of activated carbon and 10%–15% loss in regeneration have been the major deterrents in the utilization of activated carbon, especially in the developing countries. In this paper the authors show that SECR (surfactant enhanced carbon regeneration) can give excellent removal of the adsorbate. According to the authors, the results indicate that the basic premise behind this new method of regenerating activated carbon is valid. Large concentration increases in the organic adsorbate in the regenerant solution compared to that in the original waste water treated were observed and low volumes of regenerant solution were generated compared to the volume of original solution treated. The kinetics of removal of the bulk adsorbate was favourable. As the volume of the regenerant solution, the regenerant surfactant concentration, and the retention time increase, the capacity of regenerated carbon increases. The loss in adsorption capacity is also attributed to the fact that the net driving force for mass transfer (that is the concentration difference between the solid phase and bulk fluid) was also reduced substantially. So effectively combatting this problem, besides dilution, SECR can be done so that the used activated carbon could be used repeatedly and that will certainly reduce the cost of operation with no compromise with quality of treatment. (11 figures, 2 tables, 27 references)

Tyagi S K, Srivastava V K, and Singh J P. 2001
Indian Journal of Environmental Protection
21(7): 631-637

Department of Chemistry, M M College,
Modi Nagar, Meerut, India

Assessment of biomethanation potential of selected industrial organic effluents in India

394 Anaerobic digestion is gaining wider acceptance in the present scenario over aerobic treatment due to production of biogas, which can be further used for meeting a part of the energy demand. On the basis of primary and secondary data, the energy potential by the anaerobic digestion of the effluent from some of the polluting industries has been estimated in this paper. The pulp and paper industry has been found to have the maximum potential among others of the order of 1131 GWh_e/a followed by distillery with a contribution of 830 Gwhe/a to a potential of 2963 GWh_e/a equivalent electric energy. The paper also highlighted that effluents from edible oil manufacture units and coffee pulping units can be treated anaerobically. However, little work has been done in this area and therefore, pilot scale testing is required. A total potential of 565 MW plant installation with anaerobic digestion technology has been estimated. The paper also describes the nature of waste water generated by each sector, status of technologies for that sector in India and policy measures, which should be adopted for their large-scale adoption. (7 tables, 25 references)

Lata K, Kansal A, Balakrishnan M,
Rajeshwari K V, Kishore V V N. 2002
Resources, Conservation and Recycling
35(3): 147-161

TERI, Darbari Seth Block, Habitat Place, Lodhi
Road, New Delhi - 110 003, India
<kusumj@teri.res.in>

Efficiency study of GAIL effluent treatment plant

395 The discharge of sewage and industrial waste, treated or untreated, to surface water has exceeded the assimilative capacity of the receiving water bodies. The resulting pollution poses a threat to aquatic life, water supply, and groundwater. This threat has stimulated the quest for better treatment and disposal process, which will greatly reduce the pollution load that the waste water contribute to the surface water. In this context an effort has been made in evaluating the performance and efficiency of the ETP at GAIL (Gas Authority of India Ltd) in Auraiya, Uttar Pradesh. The results show that the performance of the ETP is very good. The significant environment parameters such as pH, TSS, phenol, oil, and grease are within the limits prescribed by the Uttar Pradesh Pollution Control Board. Hence, it can be concluded that there is no harmful effect of the waste water generated by GAIL on the surrounding environment. The authors recommend (1) daily monitoring of influent and effluent of the waste water treatment plant and also combined discharges; (2) the waste water having little copper and chlorinated compounds shall be treated within the plant before sending it to central waste water treatment unit; (3) the guard pond proposed to be provided at the end of the treatment plant should have two days detention time; (4) daily effluent discharge should be continuously monitored for pH, Cl, NO_3, PO_4 and other significant parameters; and (5) organic sludges from the treatment plant should be used as manure for green belt development. (3 tables, 4 references)

Parmar P S and Chaurasia S. 2001
Indian Journal of Environmental Protection
21(7): 638-641

Institute of Environmental Science,
Mahatma Gandhi Gramodaya
Vishwavidyalaya, Chitrakoot - 485 331, India

Environmental protection information

396 The problem of high fluoride concentration in ground water resources has become one of most important toxicological and geo-environmental issues in India. This paper reviews the prevalence of fluorosis in endemic states of Andhra Pradesh, Karnataka, Tamil Nadu, Uttar Pradesh, Haryana, Punjab, Maharashtra, Gujarat, Rajasthan, Jammu & Kashmir, Delhi, Kerala, and Bihar. Various defluoridation technologies have been tested in several pilot projects. The Nalgonda technology and the ion-exchange technology have been compared. Based on the above literature survey the author concludes the following. The factors responsible for the spread and severity of fluorosis include (1) population growth leading to more consumption of water for daily use; (2) unplanned and indiscriminate digging of wells; (3) increased rate of industrialization; (4) high level of fluoride intake through drinking water and fluoride bearing foodstuff like tea, and chewing *supari*, tobacco, pan; and (5) unawareness towards fluorosis. It has been observed that, there is a pressing need for development and introduction of simple and inexpensive methods of water treatment. Several defluoridation technologies have been studied and the process of absorption on alumina has an edge over other methods due to its simplicity and sludge-free operation.

Lal J. 2001
Indian Journal of Environmental Protection
21(8): 753-758

Department of Chemistry, Christ Church
Degree College, Kanpur - 208 001, India

Air pollution status in Cochin City—analysis and interpretation

397 For understanding the distribution of air pollution in an area, proper analysis of ambient air quality monitoring data could be

employed. Moreover by employing time average models, maximum concentrations at various averaging time could be predicted. This is useful for finding the amount of reduction of air pollution. Studies have revealed that SPM concentrations in the Kochi city have been log-normally distributed. An average time model has been employed to estimate the highest average concentration for the time period of 1 hour, 7 days, 31 days, and so on. By estimating the highest average concentration for various time periods, it is possible to determine the required amount of air pollution reduction approximately by employing the so-called design value. (5 figures, 8 tables)

Anto G. 2001
Indian Journal of Environmental Protection
21(8): 713-719

National Environmental Engineering Research
Institute, Kochi Zonal Laboratory, CSIR
Campus, South Kalamassery,
Kochi - 683 109, India

Removal of mercury (II) from aqueous solutions and chlor-alkali industry waste water using 2-mercaptobenzimidazole-clay

398 Mercury is one of the heavy metals posing health hazards and is found in waste water coming from chlor-alkali manufacturing industries, oil refineries, paint, pharmaceutical, paper and pulp, and battery manufacturing industries. The MBI-clay (2-mercaptobenzimidazole clay) was prepared for the removal of Hg (II) from aqueous media. Adsorption of the metal ions from aqueous solution as a function of solution concentration, agitation time, pH, temperature, ionic strength, particle size of the adsorbent, and adsorbent dose was studied. The adsorption process follows a pseudo-second-order kinetics. The rate constants as a function of initial concentration and temperature were given. The adsorption of Hg (II) increased with increasing pH and reached a plateau value in the pH range 4–8. The removal of Hg (II) was found to be greater than 99% at an initial concentration of 50 mg/L. The Hg (II) uptake was found to increase with ionic strength and temperature. Further, the adsorption of Hg (II) increases with increasing adsorbent dose and decreases with adsorbent particle size. Sorption data analysis was carried out using Langmuir and modified Langmuir isotherms. Thermodynamic parameters such as changes of free energy, enthalpy, and entropy were calculated to predict the nature of adsorption. It was found that the values of isosteric heat of adsorption were varied with surface loading. The chlor-alkali industry waste water samples were treated by MBI-clay to demonstrate its efficiency in removing Hg (II) from waste water. (12 figures, 5 tables, 30 references)

Manohar D M, Krishnan K A, and
Anirudhan T S. 2002
Water Research 36(6): 1609-1619

Department of Chemistry, University of Kerala,
Kariavattom, Trivandrum - 695 581, India
<tsani@rediffmail.com>

Studies on synthesis and application of guar-gum-graft-polyacrylamide copolymer for the treatment of pulp and paper mill effluent

399 Graft copolymers of guar gum with polyacrylamide have been synthesized by grafting acrylamide onto guar gum, using a ceric-ion-initiated solution polymerization technique. The synthetic polymers have been used as flocculants for the treatment of pulp and paper industry effluents causing environmental pollution. For the effluents, both coagulation and flocculant studies have been carried out using coagulant ferric chloride and synthetic flocculant. The supernatant turbidity of the coagulated/flocculated effluent has been studied. It has been observed that due to the complex nature of the effluents, coagulation with polyelectrolytes was essential before the flocculation aid for effluent treatment. After destabilizing such effluent, guar-gum -

Hossain S K M and Das M. 2001
Indian Journal of Environmental Protection
21(7): 611-617

graft -polyacrylamide has shown effectiveness at par with the magnafloc-1011 while using very small quantity of the flocculants. (2 figures, 6 tables, 14 references)

Department of Chemical Engineering,
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Removing colour from aqueous medium by sorption on natural clay: a study with methylene blue

400 The soil serves as an important filtering medium for scavenging coloured substances and other pollutants from industrial effluents and runoff waters. The clay component of the soil plays a significant role in this process. In the present work, clay-dye interaction has been studied under laboratory conditions with respect to locally available kaolinte clay and aqueous methylene blue solution. The clay was used in 6 different forms. The effect of methylene blue concentration, amount of clay, pH, and temperature were carefully investigated. The results indicate that kaolinite can be very effective in removing a basic dye, like methylene blue from water. The adsorption capacity of raw clay is further improved with purification of the clay and on treatment with NaOH solution. Calcination of the clays, on the other hand, has been shown to reduce the adsorption capacity. The results have been well supported by fitting Freundlich and Langmuir adsorption isotherms as well as by measuring the important thermodynamic parameters, such as ΔH^0 and ΔS^0 and ΔG^0. The results have been interpreted on the basis of a spontaneous ion-exchange interaction between kaolinite and methylene blue, which is favoured by a high pH. (6 figures, 2 tables, 23 references)

Ghosh D and Bhattacharyya K G. 2001
Indian Journal of Environmental Protection
21(10): 903-910

Department of Chemistry, Gauhati University,
Guwahati - 781 014, India

Environment planning, management, and policy issues

A note on the use of the analytic hierarchy process for environmental impact assessment

401 The EIA (environmental impact assessment) is an intrinsically complex multidimensional process, involving multiple criteria and multiple actors. Multi-criteria methods can serve as useful decision aids for carrying out the EIA. This paper proposes the use of a multi-criteria technique, namely the AHP (analytic hierarchy process) for the purpose. AHP has the flexibility to combine quantitative and qualitative factors, to handle different groups of actors, to combine the opinions expressed by many experts, and can help in stakeholder analysis. The main shortcomings of AHP and some modifications to overcome these are briefly described. Finally, the use of AHP is illustrated for a case study involving socio-economic impact assessment. In this case study, AHP has been used for capturing the perceptions of stakeholders on the relative severity of different socio-economic impacts, which will help the authorities in prioritizing their environmental management plan, and can also help in allocating the budget available for mitigating adverse socio-economic impacts. (2 figures, 5 tables, 34 references)

Ramanathan R. 2001
Journal of Environmental Management 63(1): 27-35

Indira Gandhi Institute of Development
Research, Santosh Nagar, Goregaon (East),
Mumbai - 400 065, India
<ramanathan@igidr.ac.in>

Environmental impact assessment in Bangladesh: a critical review

402 Bangladesh initiated the EIA guidelines in 1992 for the water sector development. The country enacted EIA legislation in 1995 and EIA rules in 1997. Today, all major donor agencies working in Bangladesh have their own EIA guidelines. This

paper reveals that (a) the guidelines developed by the government and the donor agencies are stringent, however, there is less emphasis on monitoring; (b) proper implementation of EIAs are largely dependent on the requirements of the donor agencies; and (c) there is a lack of coordination among the various organizations involved in environmental decision-making and of adequate infrastructure to ensure proper EIA. (6 figures, 24 references)

Momtaz S. 2002
Environmental Impact Assessment Review 22(2): 163-179

School of Applied Sciences, Centre for Sustainable Use of Coasts and Catchments, University of Newcastle, Ourimbah, NSW 2258, Australia
<smomtaz@mail.newcastle.edu.au>

Environmental protection information

403 The drainage system of Kolkata is explored in the present study along with a brief overview on the perspective feature of the city of Kolkata. All the subsystems of this network have been discussed mentioning their respective disposal arrangement. A survey was also conducted to get rid of the actual scenario and collected waste water from various points in the drainage system. Subsequently, the same was characterized in the laboratory for 3 significant parameters—pH, BOD_5 at 20 °C and COD. The results of characterization was analysed to comment on pollution scenario at different sections of the existing network. It revealed that, in some points the pollution load is of serious concern whereas the rest belonged to slight to moderately polluted zones. Also remedial measure in the form of low cost treatment has been recommended for the abatement of this pollution. (3 tables, 3 figures)

Mazumder D and Roy B. 2001
Indian Journal of Environmental Protection 21(7): 657-667

Department of Civil Engineering, Bengal Engineering College, Howrah -711 103, India

Status of ambient air quality at Hazira with reference to modified air quality index

404 A case study for assessing the air environmental status due to air emissions is elaborated for the highly industrialized area of Hazira and its surroundings. The ambient air quality was monitored at 14 sampling stations. A strategy for sustainable air quality through the MAQI (Modified Air Quality Index) has been discussed. These investigations of air quality status predict that Hazira and its surrounding areas are progressing as one of the polluted zones. The MAQI computed from the observed data indicated that out of 14 sampling stations, 2 of them fall in poor, 4 in fair, and 8 in good category. Comparisons of earlier air quality index of sampling sites with the present one revealed the following. (1) From the air quality status of the study area, it appears that most of the monitoring stations are affected by air polluting activities. (2) Though the area is basically having the rural background, due to industrialization, some sites of residential and rural areas experienced poor/bad air quality. (3) From these studies it appears that MAQI is more suitable than ORAQI (Oak Ridge Air Quality Index), where each variable has its own identity in change of indices. It is also observed that MAQI's standard deviation is lower than the ORAQI's. It indicates the importance of the qualitative nature of each parameter. (4) The only remedy for prevention of this deterioration is in proper planning of urban and residential areas and siting of industries, along with stringent pollution control measures. (4 figures, 4 tables, 5 references)

Reddy M K and Suneela M. 2001
Indian Journal of Environmental Protection 21(8): 707-712

National Environmental Engineering Research Institute, Zonal Laboratory, IICT Campus, Hyderabad - 500 007, India

Application of sound intensity to industrial problems: a case study of *in situ* sound power determination in a petrochemical industry

405 The advantage of sound intensity measurement for determination of *in situ* sound power of a number of noise sources in a petrochemical industry has been carried out. The sound intensity analyser type 4437, Bruel and Kjaer, Denmark has been used. The computation of sound power has been performed individually using sound intensity measurement at several points over a hemispherical surface enclosing various types of sources in the industrial complex. The sound intensity level and sound power level for various sources in the petrochemical complex ranged between 82.1–107.5 dBA and 91.3–113.4 dBA respectively. The measurement of sound intensity level also helps in determining the direction of the propagation of acoustical energy and in computing the sound power level of the source. The sound power level data are preferred in EIA (1) for calculating the approximate sound level at a given distance from a machine operating in a specified environment, (2) to compare the noise radiated by a machine of the same type and size as well as of different types and sizes, and (3) for engineering work to assist in developing quiet machinery and equipment. (3 figures, 1 table, 3 references)

Pandya G H. 2001
Indian Journal of Environmental Protection
21(8): 703-706

National Environmental Engineering Research
Institute, Nehru Marg, Nagpur - 440 020,
India

Ambient air quality assessment of sulphur dioxide over Delhi

406 The present work is aimed to predict the air quality in Delhi. The most important task is the preparation of source inventory. The procedure for the estimation of source strength is described in detail. The work is divided into three different modes: (1) preparation of source inventory, (2) computation of sulphur dioxide concentrations using Gaussian plume model, and (3) comparison of predicted concentrations with observed data. The predicted SO_2 concentration in the north-west Delhi is critical according to the CPCB standards. The other critical areas are Okhla and Badarpur. The SO_2 concentration is high at Shahdara and its surrounding areas. At other places the concentration is moderate or low. An emission inventory for SO_2 over Delhi is prepared considering emissions from all the plausible sources, namely power plants, domestic consumption of fuel, automobiles, and industries. In spite of approximations associated with emissions and modelling techniques, the overall comparison between predicted and observed concentrations is reasonable. Hot spots of critical concentrations in north-west Delhi, south-east Delhi, and east Delhi, due to various industrial areas and power plants are identified. Preparation of source inventory is a difficult and complex task. As such, direct validation of inventories may not be possible. However, using these inventories if the model predictions are reasonable approximation of the observed values, it reflects a greater degree of confidence in the source inventory. (8 figures, 8 tables)

Mohan M and Dube M. 2001
Indian Journal of Environmental Protection
21(8): 720-728

Centre for Atmospheric Sciences, Indian
Institute of Technology, Hauz Khas,
New Delhi - 110 016, India

Dispersion of pollutants in convective low wind: a case study of Delhi

407 The transport and dispersion of pollutants becomes weak under low wind conditions resulting in large GLCs (ground level concentrations). The largest mean GLCs due to elevated sources are typically found under daytime convective conditions with moderate to weak winds in the earlier studies. Similar cases have been studied by the authors using three different dispersion models – GPM (Gaussian plume model), LWM1 (low wind model-1), and LWM2 (low wind model-2) – at few vulnerable places in Delhi. These models were used to compute the hourly GLCs of SO_2 due to industrial and power plant sources. The performance of these models has been compared against the observed data to identify one of the models appropriate for dispersion of pollutants in low wind convective conditions, which are frequently occurring meteorological conditions in Delhi and also in urban cities of India. This evaluation has been performed at four receptors by using three different methods: (1) comparison of hourly concentrations of the models against observed data, (2) Quantile-Quantile-plots, and (3) statistical measures. It has been concluded by the authors that GPM is always overpredicting and LWM2 is consistently underpredicting the concentrations, whereas LWM1is performing better than GPM and LWM2. Thus, LWM1 may be recommended for studying dispersion of pollutants from elevated point sources in low wind convective conditions. (5 figures, 2 tables, 28 references)

Goyal P and Rama Krishna T V B P S. 2002
Atmospheric Environment 36(12): 2071-2079

Centre for Atmospheric Sciences, Indian Institute of Technology, Hauz Khas, New Delhi - 110 016, India <pramlia@cas.iitd.ernet.in>

Environmental economics

Economic valuation of health impacts of air pollution in Mumbai

408 Mortality and morbidity evaluation in the present work considers an average scenario for the society. Daily wage and average annual income needs to be considered for different income groups of the society for morbidity and mortality evaluation. The valuation methodology adopted gives a good, but conservative, idea of health damage costs. However, inclusion of carcinogenic effects of certain air pollutants and consideration of damage to health due to a greater number of pollutants, will give higher damage costs. Further studies are being aimed at including property damages, carcinogenic effects and ecological damages, and more extensive air quality monitoring both indoors and outdoors. As it was clear that the avoidance cost is 29% less than the damage cost, policy and government intervention and public awareness in this regard needs to be created so as to save the individual and government expenditure. The quality of life will also be enhanced if pollution avoidance measures are promoted. (6 tables, 8 references)

Srivastava A and Kumar R. 2002
Environmental Monitoring and Assessment 75(2): 135-143

Mumbai Zonal Laboratory, National Environmental Engineering Research Institute, Mumbai - 400 018, India

Sustainable development

Environmentally sustainable rural development in India

409 The Earth Summit (United Nations Conference on the Environment and Development) held in 1992 in Rio de Janeiro puts environmentally sustainable development at the forefront of global concerns. Agriculture is the base of India's national economy. Only with sustainable agriculture and rural development can overall sustainable development in India will be

Raffi S M and Ramanujam T K. 2001
Indian Journal of Environmental Protection
21(9): 852-855

Department of Chemical Engineering, Indian Institute of Technology, Chennai - 600 036, India

ensured and, therefore, it deserves high priority. Sustainable development is the only path that the Indian rural people can follow in order to eradicate poverty. This paper describes the need for an environmentally sustainable rural development in India. Particular attention is paid to issues like, environmental education, water resources management, energy management, and forest management in rural India. Rural development involves rural communities themselves and many of the major systems of the economy and society. Efforts on rural development would reduce some of the dysfunctional aspects of further metropolitan settlement. The fundamental education is the creation of sustainable environment in which people can live and work. Establishment of protected areas for sources of drinking water supply, sanitary disposal of excreta, and using appropriate systems to treat waste water in rural areas play a vital role in rural development. The decentralization policies are expected to yield better results provided there exists harmony in various elements of rural development. Sustainable agriculture and rural development need each other and the nation needs a policy that advances both. (2 references)

Internet resources

Web sites

The Norwegian Pollution Control Authority (SFT)

http://www.sft.no/english/

The Norwegian Pollution Control Authority (SFT) is a directorate under the Ministry of the Environment. The main goal of this authority is to promote sustainable development. Among the important activities, the SFT works for the betterment of the state of the environment. This includes waste management, water pollution, and hazardous chemicals management. The site provides useful resources on maps, statistics, news, and publications.

Clean Air Technology Center (CATC)

http://www.epa.gov/ttn/catc/

The Clean Air Technology Center (CATC) serves as a resource on all areas of emerging and existing air pollution prevention and control technologies; and provides public access to data and information on their use, effectiveness, and cost. The web site provides information on news, bulletins, databases on technology and regulation, business opportunities, and products.

Clearinghouse on Eco-Efficiency for Business

http://www.mty.itesm.mx/decic/centros/ciads/cien/english/graf/home.html

The CIEN (Clearinghouse on Eco-Efficiency for Business) is a service that facilitates information on eco-efficiency and sustainable development for any business interested in these issues. Businesses in developing countries are CIEN's potential market base, however, it can service any entity with information needs regarding eco-efficiency and sustainable development—including governments, academia, society organizations, and students.

ENSIC Online Bibliographic Database

http://www.clair.ait.ac.th/ensic-biblio/

ENSIC bibliographic database contains more than 10 000 records in environmental management and engineering for ENSIC members. The broad subjects covered include water pollution, waste management, air/noise pollution, soil pollution, clean technology, land management, biological resources management, health and sanitation, environmental impact assessment, environmental policy and regulation, and environmental economics. The records are bibliographic references scanned from books, journals, research reports, and conference proceedings published worldwide.

IISD Global Green Standards

http://iisd1.iisd.ca/greenstand/default.htm

IISD Global Green Standards is a report of the IISD (International Institute for Sustainable Development), which can be downloaded from this site. It is a heads-up analysis about

ISO 14000 standards. In this publication, IISD tracks the development of these standards and provides interpretation of them. The site also contains a large number of documents of the ISO 14000 standards. The site also hosts the ISO 14000 Information Centre.

Global Recycling Network

http://grn.com/

The GRN (Global Recycling Network) is a free-access public web site dedicated to recycling-related information. The site provides a variety of services and products. These include web-publishing services, online sales and catalogues, advertising, discussion forums, commodity prices, company directories, equipment information, company showcase, and other online information resources including news and links.

Greenpeace Toxics Campaign

http://www.greenpeace.org/toxics.html

Greenpeace International Toxics Campaign home page includes copies of key toxic reports, news. It has links to programme initiatives on toxic chemicals including POPs (persistent organic pollutants), PVC, cleaner production, chlorine industry, health effects, ship braking, and Basel trade ban.

International POPs Elimination Network

http://www.ipen.org

The IPEN (International POPs Elimination Network) is a global network of public interest non-governmental organizations united in support of a common POPs elimination platform. The site provides several documents and publications, recent and archived news, POPs handbook, events and meetings, and links to related organizations.

Mailing lists

P2Policy

The P2Policy list server is administered by the National Pollution Prevention Roundtable Office and funded by the Environmental Protection Agency's Pollution Prevention Division. The list server provides a discussion forum on pollution prevention policy and legislative developments. Subscribers are allowed to query and comment on topics related to pollution prevention policy development, regulatory integration issues and legislation. For subscription, send mail to tyronefoster@compuserve.com>.

P2Tech

P2Tech is a list server dedicated to the free discussion of technical strategies for implementing pollution prevention. For subscription, send mail to <listman@wmrc.hazard.uiuc.edu>.

EPA's Office of Reinvention

The focus of this list server is on environment regulation. For subscription, send mail to <listserver@unixmail.rtpnc.epa.gov> with the words 'subscribe reinvention' and include 'your name' in the body of the message.

The Water Forum

The Water Forum is an open forum for discussions on water resources issues, including groundwater and surface water, drinking water, waste water, wetlands, recreational use, fisheries and wildlife, and any other relevant water resources and or sanitation topics. For subscription, send mail to <waterforum-subscribe@eGroups.com>.

AP-CPNet

http://www.tei.or.th The AP-CPNet (Asia Pacific Cleaner Production Network) has been initiated by the Cleaner Technology Information Center, Thailand. The main purpose of AP-CPNet is to accelerate a dialogue between the various stakeholders in cleaner production in the Asia Pacific region and to bring together all those who are working towards achieving this goal of promotion of cleaner production concept in this region. For subscription, send mail to <ctic@tei.or.th> or <mandar@tei.or.th>.

ENS

http://ens.lycos.com/ The ENS (Environment News Service) is a daily e-mail based international newswire service dedicated to the latest environmental news. To subscribe, send an e-mail message to <listproc@envirolink.org>.

Occasional publications

From standards, patents, newsletters, government documents and notifications, annual reports, etc.

Environmental patents

Pollution cleanup system and method

Patent on *Pollution cleanup system and method*
Patent number US 6,406,634
Invented and filed by Armes R A, 7630 N. Fox Hollow Road, Bloomington, IN 47408 on 4 June 2001
Granted on 18 June 2002
[Source: www.uspto.gov]

A pollution cleanup system and method is especially useful for the on-site treatment of polluted water. The system includes a filter media, a pump, a holding tank and valves for operation of the system. Polluted water is passed through the filter media and cleaned. It is then tested for purity and passed, for example, into a storm drain. If needed for further cleaning, the water may be recycled through the filter media.

Anti-air pollution and energy conservation system

Patent on *Anti-air pollution & energy conservation system for automobiles using leaded or unleaded gasoline, diesel or alternate fuel*
Patent number US 6,398,851
Invented by Bose R K, 14346 Jacob La., Centreville, VA 20120-3305 on 7 September 2000
Granted on 4 June 2002
[Source: www.uspto.gov]

Exhaust gases from an internal combustion engine operating with leaded or unleaded gasoline or diesel or natural gas, are used for energizing a high-speed gas turbine. The convoluting gas discharge causes a first separation stage by stratifying of heavier and lighter exhaust gas components that exit from the turbine in opposite directions, the heavier components having a second stratifying separation in a vortex tube to separate combustible pollutants from non-combustible components. The non-combustible components exit a vortex tube open end to atmosphere. The lighter combustible, pollutants effected in the first separation are bubbled through a sodium hydroxide solution for dissolving the nitric oxide, formaldehyde impurities in this gas stream before being piped to the engine air intake for re-combustion, thereby reducing the engine's exhaust pollution and improving its fuel economy. The combustible, heavier pollutants from the second separation stage are piped to air filter assemblies. This gas stream convoluting at a high-speed through the top stator-vanes of the air filters, centrifugally separates the coalescent water, aldehydes, nitrogen dioxides, sulfates, sulfur, lead particles which collect at the bottom of the bowl, wherein it is periodically released to the roadway. Whereas, the heavier hydrocarbon, carbon particles are piped through the air filter's porous element to the engine air intake for re-combustion, further reducing the engine's exhaust pollution and improving its fuel economy.

Water pollution evaluating system

Patent on *Water pollution evaluating system with electrolyzer*
Patent number US 6,235,188
Invented by Nakamura S, Fukuzuka K, Misawa K, and Okuda A.

When the water stored in a reservoir 1 and containing chlorine ion and/or bromine ion is supplied to and circulated through an electrolyzer 4 and electrolyzed therein to create hypochlorous acid and/or hypobromous acid so that the water is purified and sterilized, a potential difference measuring unit is interposed between a measuring *electrode dipped into the water containing the hypochlorous acid and/or hypobromous acid and a reference electrode dipped into water having a prescribed electric conductivity and containing neither hypochlorous acid nor hypobromous acid to thereby evaluate a measured potential difference as a COD value which is an index of pollution. With this arrangement, a polluted state of water can be promptly and simply evaluated as the COD value.*

Filed by Omega Company Ltd, Japan
on 6 May 1999
Granted on 22 May 2001
[Source: www.uspto.gov]

Environmental standards

Toxicity standard for Indian industries

In India, presently the toxicity/bioassay standards prescribed for various industries are based on the BIS (Bureau of Indian Standards) standard IS: 6582-1971. This method is based on the determination of LC_{50}, the concentration of sample effluent on semi-logarithmic scale at which 50% of fish could survive. However, based on the recommendations of the CPCB (Central Pollution Control Board), the BIS has revised the method IS: 6582 (Pt II)-2001. The expression of this method is represented through toxicity factor (T_f), which is minimum number of times an effluent is required to be diluted for obtaining no mortality for Zebra fish in 48 hours. The higher the T_f value, the greater will be the toxicity of the sample waste water. The CPCB has recommended the below mentioned T_f value as Minimal National Standard for the following types of industries.

	T_f recommended	
Industry category	*Existing standard*	*New standard*
Pesticide	4*	2
Dyes and dyes intermediates	4*	2
Textiles	1	1

* T_f should be 2 after three years of notification
[Source: Green Business Opportunities. 2002 8(2): 7]

Environmental law/ Government notifications

Draft Notification for amending the Coastal Regulation Zone (CRZ) Rules, 1991

The Ministry of Environment and Forests, Government of India issued a Draft Notification (dated 11 January 2002) thereby proposing to amend the CRZ (Coastal Regulation Zone) Rules that were brought out in 1991. The amendments are proposed primarily to permit the construction of dwelling units and development of infrastructural facilities for the local inhabitants, housing schemes of Urban Development Authorities which had been approved prior to 19 February 1991, facilities and activities including setting up of non-polluting industries in the field of Information Technology and other service industries in the SEZs (Special Economic Zones) and salt harvesting by solar evaporation of sea water in the CRZ. The following are the prime features of the Draft Notification.

- The distance from the High Tide Line shall apply to both sides in the rivers, creeks, and backwaters and may be modified on a case to case basis for reasons to be recorded while preparing the Coastal Zone Management (CRZ) Plans. However, this distance shall not be less than 100 meters or the width of creek, river, or backwaters whichever is less.

- This distance mentioned in the above clause may be reduced to 50 metres or the width of the rivers, creeks, or backwaters, whichever is less, for the stretches specified by the Central Government or an authority designated by it, for permitting construction of dwelling units for local inhabitants if the following conditions are satisfied
  - the area is not classified as CRZ-1(I),
  - the availability of groundwater is assured by the concerned authority and proper facilities for treatment and disposal of waste water and sewage are certified by the concerned local authority,
  - the proposed construction is not used for any commercial activity, and
  - at least one of the following conditions is fulfilled
    - the area is classified as CRZ-11,
    - the density of the Panchayat/ward area is not less than 400 persons per square kilometre,
    - the built-up in the Panchayat/ward is already 1/3rd of the Panchayat/ward,
    - the area should be with an elevation of more than 10 metres from the mean sea level or any point within 100 metres of the inland tidal water body.

The following important amendments are also proposed vide the said notification.

- Non-polluting industries in the field of information technology and other service industries are permitted in the CRZ.
- For the clearance, which shall be given for any activity within the CRZ if it requires waterfront and foreshore activities, it is proposed that the assessment shall be completed within a period of 90 days from the receipt of the requisite documents and data from the project authorities, and the decision conveyed within 30 days thereafter.
- In the list of activities which requires environment clearance from the Ministry of Environment and Forests (Government of India) the following activities will be added: housing schemes in CRZ area, mining of rare minerals and specified activities/ facilities in SEZs.
- In CRZ – between LTL (Low Tide Line) and HTL (High Tide Line) – in areas which are not ecologically sensitive and important salt harvesting by solar evaporation pond is permitted.
- In the CRZ-111, the following activities are permitted. Construction of dispensaries, school, public rain shelters, community toilets, bridges, roads and provision of facilities for water supply, drainage, sewage which are required for the local inhabitants may be permitted on a case to case basis, by the Central Government or Coastal Zone Management Authority constituted for the State/Union Territory.
  [Source: Green Business Opportunities. 2002, 8(2): 6-7]

Landfill Regulations (England and Wales)

Regulations have been laid before Parliament, which will, if approved, implement the regulatory and technical requirements of the EU Landfill Directives in England and Wales. The Landfill Directive sets out a range of controls, which must be applied to both new and existing landfill sites. Whilst many of the Directive's requirements reflect those already in place in Britain under the Waste Management Licensing Regime, it will nevertheless introduce some key changes to current landfill practice, including

- the separation of landfills into three types: for only hazardous, non hazardous or inert waste—this will end the current UK practice of co-disposing of hazardous and non-hazardous waste by 2004,
- the requirement to treat most wastes before landfill,
- ban on the disposal of certain wastes going to landfill for disposal including liquid wastes, certain hazardous wastes, and tyres, and
- introduction of waste acceptance criteria setting out the types of waste that can be accepted at each of the three types of landfills.

Together these requirements will represent a major challenge to both landfill operators and waste producers who currently dispose of waste to landfill. Operators of existing landfill sites will be required to produce site conditioning plans by 16 July 2002 setting out details of the site and any corrective measures the operator intends to undertake to meet the requirements of the directive. In advance of the regulations coming into effect, the Environment Agency has already published and circulated a site-conditioning plan to all operators containing guidance and standard form for completion. A copy of the regulations can be found on the HMSO website at http://www.legislation.hmso.gov.uk/si/dsis2002.htm

[Source: Warmer Bulletin. 2002 (May): 9]

Calendar of events

Conferences, congresses, seminars, symposiums, and workshops

Jaipur, India
1-3 March 2002

International Conference on Techno-commercial Aspects of Decentralized Approach in Waste to Energy
Prof M P Poonia, Conference Convener, ICWE 2002, Mechanical Engineering Department, Malaviya Regional Engineering College, J L N Marg, Jaipur - 302 017, India

Fax +91 141 702 954
E-mail mppoonia@icwe2002.com, icwe@recjai.ernet.in
Tel. +91 141 702 708 • *Web site* www.icwe2002.com

Tirupathi, India
24-26 March 2002

National Seminar on Conservation of Eastern Ghats
Environment Protection Training and Research Institute,
91/4 Gachibowli, Hyderabad – 500 032, India

Fax +91 40 300 0361 • *E-mail* uma@eptri.com, info@eptri.com
Tel. +91 40 300 1707, 300 1241 • *Web site* www.eptri.com

Yorkshire, UK
8-9 April 2002

The Eighth Annual International Sustainable Development Research Conference 2002
Elaine White, Conference Coordinator, ERP Environment,
PO Box 75, Shipley, West Yorkshire BD17 6EZ, UK

Fax +44 1274 530 409 • *E-mail* elaine@erpenv.demon.co.uk
Tel. + 44 1274 530 408 • *Web site* www.erpenvironment.org

Jaipur, India
11-13 April 2002

International Conference on Water Quality Management: South Asian Perspective
Ms Rekha Sinha, International Life Sciences Institute–India,
Y-40 B First Floor, Hauz Khas, New Delhi – 110 016, India

Tel. +91 11 696 8752, 652 3477 • *E-mail* Rsinha@id.eth.net

Philadelphia, USA
6-8 May 2002

10th Annual North American Waste-to-Energy Conference
The Solid Waste Association of North America, PO Box 7219,
Silver Spring, MD 20907-7219, USA

Fax +1 301 589 7068, 585 0297 • *Tel.* +1 800 467 9262

Munich, Germany
13-17 May 2002

IFAT 2002: 13th International Trade Fair for Environment, Waste Water & Waste Disposal

Fax +49 89 949 20259 • *E-mail* info@messe-muenchen.de
Tel. +49 89 949 20260

Mumbai, India
30 May-1 June 2002

EnviroVision 2002
Mr Satish Chilekar, Chairman, EnviroVision 2002, Indian Environmental Association, C/o Klean Environmental Consultants (P) Ltd, 410 Emca House, 289 Shahid Bhagatsingh Road, Near Fort Market, Mumbai 400 001, India

Fax +91 22 261 1961 • *E-mail* klean@vsnl.com, water@bol.net.in
Tel. +91 22 261 7313

Udaipur, India
5-7 June 2002

NSE-11: Eleventh National Symposium on Environment
Prof G S Sharma, Chairman, Symposium Organizing Committee, Dean, Rajasthan College of Agriculture, Maharana Pratap University of Agriculture and Technology, Udaipur – 313 001, India

Fax +91 294 420 447, 411 682 • *E-mail* nse11gss@usa.net
Tel. +91 294 417 835, 418 976

Graz, Austria
19-21 June 2002

11th International Symposium on Transport and Air Pollution
Institute for Internal Combustion, Engines and Thermodynamics, A-8010 Graz, Inffeldgrasses 25, Austria

Fax +43 316 873 8080 • *Tel.* +43 316 873 7584, 873 7596
E-mail sturm@vkmb.tu-graz.ac.at, minarik@vkmb.tu-graz.ac.at

Monterey, USA
30 June-5 July 2002

Indoor Air 2002: 9th International Conference on Indoor Air Quality and Climate
Indoor Air 2002, 343 Soquel Avenue, PMB 312, Santa Cruz CA 95062, USA

E-mail registration@indoorair2002.org
Web site www.indoorair2002.org

Segovia, Spain
1-3 July 2002

Tenth International Conference on Modeling, Monitoring and Management of Air Pollution 2002
Lucky Southcott, Conference Secretariat, Air Pollution 2002, Wessex Institute of Technology, Ashurst Lodge, Ashurst, Southampton S40 7AA, UK

Fax +44 238 292 853 • *E-mail* isouthcott@wessex.ac.uk
Tel. +44 238 293 223 • *Web site* www.wessex.ac.uk

Istanbul, Turkey
8-12 July 2002

ISWA World Environment Congress and Exhibition
Prof Dr Gunay Kocasoy, Turkish National Committee on Solid Wastes, Bogazici University, 80815 Bebek, Istanbul, Turkey

Fax +90 212 265 2187 • *E-mail* iswa2002@iswa2002.org
Tel. +90 212 263 1540 Ext. 2395, 1276
Web site www.iswa2002.org

Barcelona, Espana
11-16 August 2002

Dioxin 2002: 22nd International Symposium on Halogenated Environmental Organic Pollutants and POPs

Fax +34 93 204 5904 • *E-mail* chair@dioxin2002.org
Tel. +34 93 400 6100 Ext. 324

Goa, India
19-23 August 2002

CARG-2002: Workshop on Commercial Applications of Remote Sensing and GIS with Special Emphasis on Geoinformatics for Environment Impact Assessment
R P Dubey, Organising Secretary, CARG-2002, VASC/RESA,
Space Applications Centre (ISRO), Ahmedabad – 380 015, India

Fax +91 79 676 2735
E-mail rpdubey@resa-sac.org, rpdubey@hotmail.com
Tel. +91 79 677 4104/4022 • *Web site* www.resa-sac.org

Stockholm, Sweden
2 September-4 October 2002

International Training Programme on Environmental Management and Development
SIS Forum AB, SE-118 80 Stockholm, Sweden

Fax +46 8555 52201 • *E-mail* international.forum@sis.se
Tel. +46 8555 52250

Cadiz, Spain
4-6 September 2002

First International Conference on Waste Management and the Environment: Waste Management 2002
Gabriella Cossutta, Conference Secretariat, Waste Management 2002, Wessex Institute of Technology, Ashurst Lodge, Ashurst,
Southampton S040 7AA, UK

Fax +44 238 029 2853 • *E-mail* gcossutta@wessex.ac.uk
Tel. +44 238 029 3223

Birmingham, UK
10-12 September 2002

Recycling and Waste Management Exhibition

Fax +44 20 8277 5560 • *E-mail* jenny.coombes@emap.com
Tel. +44 20 8277 5541 • *Web site* www.rwm2002.com

Munich, Germany
11-13 September 2002

3rd International Symposium on Anaerobic Digestion of Solid wastes

Fax +49 89 2891 3718 • *E-mail* dalhoff@bv.tum.de
Tel. +49 89 2891 3797

Crete, Greece
18-25 September 2002

Atmospheric Chemistry in the Earth System: From Regional Pollution to Global Change
IGAC Core Project Office, Massachusetts Institute of Technology,
Building 24-409, Cambridge, MA 02139-4307, USA

Fax +1 617 253 9886 • *E-mail* igac@mit.edu
Tel. +1 617 253 9887

Warwickshire, UK
24-26 September 2002

Waste 2002: Integrated Waste Management and Pollution Control Research, Policy and Practice
Ms Sherrie Sullivan, Waste 2002 Conference Office, The
Barclay Centre, University of Warwick Science Park, Coventry,
CV4 7EZ, UK

Fax +44 24 7669 2238 • *E-mail* info@waste2002.com
Tel. +44 24 7641 2170 • *Web site* www.waste2002.com

Durban, South Africa
30 September-4 October 2002

Wastecon 2002-Internaitonal Congress and Exhibition of the Institute of Waste Management of Southern Africa

Fax + 27 31 763 3041 • *E-mail* Westcon2002@iafrica.com
Tel. +27 31 763 3222

Vienna, Austria
2-4 October 2002

International Conference on Avoiding Municipal Waste
Gutwinski Management GmbH, Lohnsteinstraße 36, A-2380
Perchtoldsdorf, Austria

Fax +43 1 866 32-33 • *E-mail* office@gutwinski.at
Tel. +43 1 866 320 • *Web site* www.gutwinski.at,
www.abfall.wien.at

Enschede, The Netherlands
7 October-9 November 2002

Energy Management and Cleaner Production in Small and Medium Scale Industries
Ms Wendie Klieverik, Technology and Development Group,
University of Twente, PO Box 217, 7500 AE Enschede,
The Netherlands

Fax +31 53 489 3087 • *E-mail* courses@tdg.utwente.nl
Tel. +31 53 489 4377/3539 • *Web site* www.utwente.nl/tdg

Israel
9 October-8 November 2002

International Program on Environment Management
TIVON 36 000, PO Box 1070, Israel

Fax +972 4 9830 227
E-mail International_Department@galilcol.ac.il
Tel +972 4 983 7444, 983 7555 • *Web site* www.galilcol.ac.il

Bhopal, India
19-20 October 2002

18th National Convention of Environmental Engineers and National Seminar on Solid Waste Management
The Secretary, The Institution of Engineers (India), MP State
Centre, Dr M Visvesvaraya Marg, Near Kasturba Hospital,
Hobibganj, Bhopal – 462 024, India

Tel. +91 755 784 572, 506 387 • *E-mail* ieimpsc@sancharnet.in

Aalborg, Denmark
21-23 October 2002

3rd EURO Environment Conference on Business and Sustainable Performance
Aalborg Kongress & Kultur Centre, Europe Plads 4, Boks,
149-DK-9100 Aalborg, Denmark

Fax +45 99 35 5543 • *E-mail* euro@akkc.dk
Tel. +45 99 35 5518
Web site www.akkc.dk, www.euro-environment.dk

London, UK
22-24 October 2002

Sustainable Energy 2002

Tel. +44 20 7850 7502 • *Web site* www.sustainable-expo.org

Delft, The Netherlands
24-25 October 2002

Sustainable Development: a challenge for engineers
Delft University of Technology, Faculty of Technology Policy
and Management, Technology Assessment, Jaffalaan 5,
NL 2628 BX Delft, The Netherlands

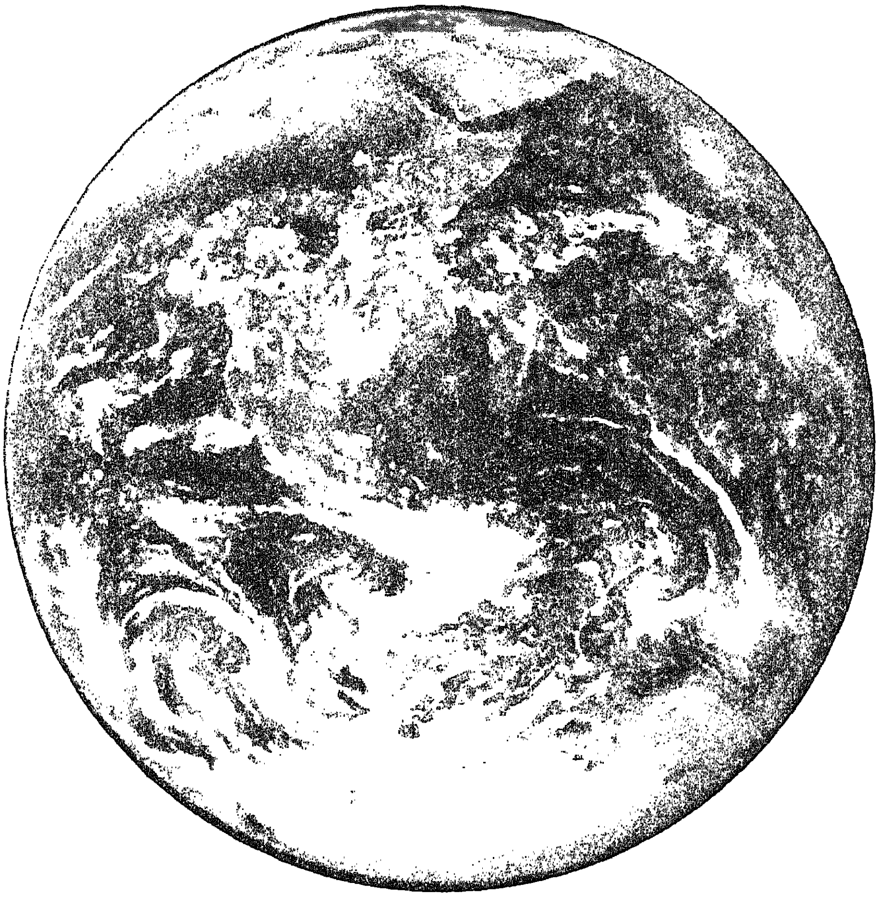
Fax +31 51 278 3177 • *E-mail* k.f.mulder@tbm.tudelft.nl
Tel. +31 51 278 1043
Web site www.odo.tudelft.nl/conference.html

Singapore
29-30 October 2002

Waste Management Asia 2002
Waste Management Asia 2002, c/o WBR (S) Pte Ltd,
1 Shenton Way, 13-07, Singapore 068803, Singapore

Fax +65 6224 2515, 6226 2941 • *E-mail* equire@iqpc.com.sg
Tel. +65 6325 6330 • *Web site* www.iqpc.com.sg/AS-529

Global Environment Review



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Policy forum

Sixteenth sessions of the subsidiary bodies to the UNFCCC

The sixteenth sessions of the subsidiary bodies to the UNFCCC (United Nations Framework Convention on Climate Change) were held during 5–14 June 2002 in Bonn, Germany. The focus of these sessions was essentially on the implementation of the Marrakesh Accords and on issues under the UNFCCC.

Key issues

The SBSTA (Subsidiary Body for Scientific and Technological Advice) met from 5–14 June 2002, and adopted draft conclusions on various issues including

- the IPCC (Intergovernmental Panel on Climate Change) Third Assessment Report;
- greenhouse gas inventories from Annex I parties;
- activities implemented jointly;
- land use, land-use change, and forestry;
- technology transfer;
- the relationship between efforts to protect the ozone layer and climate change;
- policies and measures;
- cooperation with relevant international organizations; and
- education, training, and public awareness.

The Subsidiary Body for Implementation met from 10–14 June 2002, and adopted conclusions on

- national communications,
- financial mechanisms,
- the implementation of UNFCCC Articles 4.8 and 4.9 (adverse effects),
- the Least-Developed Countries Expert Group, and
- capacity building.

A major issue, perceived to modify the Kyoto Protocol, was the proposal by Canada to be allowed credit up to 350 million tonnes of CO_2 for clean energy exports to the US. This issue evoked interest from Saudi Arabia and Russia along with disagreement from several other countries, and was referred to the agenda for the next meeting of the subsidiary bodies.

The other major issue was the request made by a group of countries from Central Asia, Caucasus, and Moldova; that the words 'developing countries' be substituted by 'developing countries and other parties not included in Annex I'. Even Kazakhstan, which is counted as an economy in transition, has signed this letter of request. It was agreed that consultations on this matter would continue and be reported during the seventeenth sessions of the subsidiary bodies.

Parties also considered preparations for the WSSD (World Summit on Sustainable Development), at Johannesburg, and for CoP-8 (Eighth Session of the Conference of the Parties to the UNFCCC), which is being hosted by the Government of India at New Delhi during 23 October – 1 November 2002.

Status of the ratification process

In addition to Canada delaying the ratification process based on clean-energy exports, Russia informed the sessions that its national consultative process would be completed by the end of this year (i.e. 2002). Russia's stand shows its interest in Canada's proposal for credits on clean-energy exports and also its desire for more economic gains. As is well known, Australia, a major exporter of coal has decided not to ratify the Kyoto Protocol. Canada, Russia, and Australia put together constitute about 22.8% of the Annex I-emissions in 1990. The present status of 77 countries having ratified the Protocol corresponds to 36% of the Annex I-emissions. Given that the condition for the Kyoto Protocol to come into force is 55%, there are clearly no prospects of this happening by CoP-8. The withdrawal of the US has resulted in the overall dilution of the Protocol commitments and further reduction in the demand for the CDM (clean development mechanism).

The CDM Executive Board

The fourth meeting of the CDM Executive Board was held during 9–10 June 2002 in Bonn, Germany. The agenda of this meeting included the following key issues for the operationalization of the CDM.

Accreditation of operational entities

The CDM Executive Board started the process for the accreditation of operational entities by making available the draft application and detailed procedures. It proposed to launch the process formally by the end of July 2002. The Board decided to charge a non-reimbursable application fee of 15 000 dollars and also established a CDM Accreditation Panel for the purpose of reviewing applications. It also invited nominations of qualified experts to the Accreditation Panel, particularly from Africa, Central and East Europe, Latin America, and the Caribbean.

Project design document

The Executive Board reviewed the draft PDD (project design document) for the CDM, and noted the need for simplification. It decided that the project-cost and other financial details would not be included in the PDD, and that the existing environmental impact assessment and sustainable development reporting in the host country will be accepted. The Board planned to finalize the PDD at its fifth meeting.

Simplified modalities and procedures for small-scale CDM project activities

The Executive Board had previously established a panel to recommend simplified modalities and procedures for small-scale CDM project activities. At its fourth meeting, the Board noted the report of the first meeting of this panel, and agreed to invite two panel members to present draft recommendations at the Board's next meeting.

Guidelines of the methodologies for baseline and monitoring plans

Another panel set up by the Executive Board considers new methodologies for baseline and monitoring plans. It was agreed that for each new methodology, experts selected from a roster maintained by the UNFCCC Secretariat would conduct a desk-review of the validity of the methodology. The Board further decided to charge a registration fee for proposed project activities.

A notable development was that the US expressed interest in participating as an observer of the CDM Executive Board meeting, despite its non-ratification of the Kyoto Protocol.

Media on global environmental issues

Time to focus on climate change and food security

The Economic Times
24 April 2002

Being the first developing country representative to head the IPCC comes at the right time for the Indian environment expert Dr R K Pachauri. Taking over as Chairman of the international programme under the UNEP (United Nations Environment Programme) and the WMO (World Meteorological Organization) at a time when environment is occupying centre stage in the world economy, Dr Pachauri has a single point agenda—to push regional issues to the top of the agenda and to stress the economic cost-benefit analysis of every aspect of climate change management. Dr Pachauri, who is Director-General at TERI, is aware that there are serious environmental hazards that are unattended in the region. Only a concerted effort to bring it into the civic consciousness would help the IPCC's otherwise purely *research, knowledge-gathering, and recommendatory* efforts, he concedes. Since its inception in 1988, the IPCC has brought out three climate change assessment reports. While the first two led to the UNFCCC and the Kyoto Protocol, respectively, and the third completed much of the relevant groundwork; the fourth report may well lead to concrete and workable solutions, it is hoped.

EU says it met 2000 emissions targets

UN Wire
30 April 2002
http://www.unfoundation.org/unwire/2002/04/30/current.asp#26065

The EU (European Union) has announced that it reached its GHG (greenhouse gas) emission targets for 2000, under the Kyoto Protocol on climate change but said future targets may prove more elusive. The EU carbon dioxide output dropped 0.5% between 1990 and 2000, while figures for the six main gases believed to be responsible for climate change were down 3.5%, according to the European Environment Agency. Under Kyoto targets, the EU emissions were supposed to stabilize at 1990 levels by 2000. Emissions this decade are expected to rise, however, with the agency predicting a 6% jump unless strict measures are taken. The EU is supposed to reduce output by 8% between 2008 and 2012 under the protocol, but the EU Environment Commissioner Ms Margot Wallström said, 'Without additional efforts and measures at both the European and national level, the EU will not be able to reach its Kyoto target.' Germany and the UK led the bloc in reductions at 19% and 13%, respectively. German cuts came mostly from the restructuring of the East German industry, while the British drop resulted from large-scale switching to cleaner gas fuels. These two countries are the EU's biggest polluters. The worst performer was Spain, where emissions were up 33.7% during the last decade.

The Netherlands and The World Bank Group sign deal on credits

UN Wire
3 May 2002
http://www.unfoundation.org/unwire/2002/05/03/current.asp#26133

The World Bank Group's IBRD (International Bank for Reconstruction and Development) and IFC (International Finance Corporation) signed an agreement with the Netherlands to set up two global trading houses for buying and selling GHG emissions reduction credits. The new system, outlined under the UNFCCC, will allow countries and other entities to receive funding from the new facilities for projects that reduce GHGs. In return, the facilities will sell the reduction credits earned by these projects to countries that exceed their emission limits under the treaties. The IBRD facility will seek to fund up to about 62 million dollars in national projects, including investments in renewable energy, energy efficiency, and switches to cleaner fuels. Forest-related projects will not be eligible for funding. Under the agreement with the Netherlands, the trading house will run for two years, with the opportunity to renew for another two years at the same level of capitalization.

UNEP and Chinese University create institute

UN Wire
13 May 2002
http://www.unfoundation.org/unwire/2002/05/13/current.asp#26346

The UNEP (United Nations Environment Programme) and Shanghai's Tongji University have signed an agreement to establish the UNEP-Tongji Institute for Environment and Sustainable Development. The Institute will focus on developing educational programmes to build research, technical, and managerial capacity among the developing countries of the Asia-Pacific region. The Institute is expected to establish a field ecological station to monitor long-term land-use changes resulting from the construction of the Three Gorges Reservoir and the resulting relocation of 1.1 million people in China. It will also assist in environmental planning for the 2008 Olympic Games and China's Great Western Development Program. Such projects are expected to yield case studies, research, and analysis for the Human Ecosystem Model being developed under UNEP's Global Environmental Outlook, the UNEP-led Millennium Ecosystem Assessment, and planned programmes on global land cover changes and flood protection on the Yangtze River.

Iceberg, 56-km long, breaks away from Antarctica

The Statesman
23 May 2002

An iceberg named D-17 broke off from Antarctica on 22 May, the National Ice Centre has reported. It broke away from the Lazarev Ice Shelf, a large sheet of glacial ice and snow extending from the Antarctic mainland into the southeastern Weddell Sea. The new iceberg is 55.5 km long and 11 km wide. It was observed on an image collected by the Defense Meteorological Satellite Programme. However, new measurements indicate the ice in parts of Antarctica is thickening, reversing earlier estimates that the sheet was melting. Scientists reported in January that new flow measurements for the Ross ice streams indicate some of their movement has slowed or halted, allowing the ice to thicken.

Japan ratifies Kyoto pact, to urge the US to go green

The Indian Express
5 June 2002

Japan has ratified the Kyoto Protocol on global warming signed in 1997 and said it would urge other countries including Russia and the US to do the same. Under the Protocol, industrialized nations must cut emissions of GHGs by an average of 5% over the period 2008–12, compared with 1990 levels. Japan has pledged to cut its output by 6%. Environmentalists said Japan would have difficulty meeting its target, since the volume of emissions had risen since 1990. Following the ratification, Japan's foreign and environment ministers will write to countries including Russia and the US urging them to also ratify the treaty.

Ozone-depleting substances registration made mandatory

The Hindu Business Line
7 June 2002

Industrial units in Andhra Pradesh, involved in the production, consumption, and handling of ODS (ozone-depleting substances) have to register before 19 July 2002 according to a government release. The registration of units under the ODS regulation rules with the designated authority is mandatory and those not complying have to stop using these substances. The relevant authority in the state is the Small Scale Service Institute, Balanagar. The units producing aerosol, foam, fire-extinguishers, refrigeration, air conditioning, gas-charging units, metered dose inhalers, compressors, etc. fall in the category of ODS users.

India signs global treaty on plant resources

Business Standard
12 June 2002

With India signing the International Treaty on Plant Genetic Resources for Food and Agriculture at Rome, Italy, the global convention on the conservation and sharing of plant germplasm has moved closer to coming into force. The number of countries that have already signed the treaty has now reached 27. Some more countries are expected to sign it in the next few days during the ongoing World Food Summit in Rome. The 15 member countries of the EU, as also the European Community, had signed this treaty last week while Eritrea, Egypt, Jordan, and Guinea have already ratified it as well. On behalf of India, the treaty was signed by the Agriculture Minister, Mr Ajit Singh, who is currently in Rome to attend the food summit. The Union Cabinet had recently given its nod for the signing of the treaty as well as joining the UPOV (International Convention for the Protection of New Varieties of Plants), 1978. The treaty for the first time covers conservation and sustainable use of the world's agricultural plant genetic material, as well as the fair and equitable sharing of its benefits, including the commercial benefits. The treaty, adopted by the FAO (Food and Agriculture Organization of the United Nations) in November 2001, is in harmony with the Convention on Biological Diversity. India had played a significant role in formulating this treaty, especially in the recognition of the farmers' role in preservation of plant wealth.

Brazilian Senate ratifies the Kyoto Protocol

UN Wire
20 June 2002
//www.unfoundation.org/unwire/2002/06/20/current.asp#27172

The Brazilian Senate has voted unanimously to ratify the Kyoto Protocol, a move that comes on the heels of the EU's ratification of the treaty and further isolates the US in opposition to the accord, *O Estado de Sao Paulo* reports. Because Brazil is not an industrialized country under the protocol, the treaty is no closer to achieving the conditions for its entry into force. Industrialized countries accounting for 55% of the 1990-emission levels must ratify in order for the pact to enter into force. 75 countries have ratified, fulfilling the other condition for the treaty to take effect. Nevertheless, without the accession of the US, which is responsible for 36.1% of industrialized countries' emissions in 1990, or of Russia, which accounts for 17.4%, and several smaller industrialized countries, it is unlikely the protocol can come into force. Countries that have ratified so far account for 35.8% of the 1990 emission levels.

UK carbon-emissions prices rise as trade picks up

Planet Ark
21 June 2002
http://www.planetark.org/dailynewsstory.cfm/newsid/16518/newsDate/21-Jun-2002/story.htm

Trade in the fledgling UK market for carbon emissions allowances has picked up, with prices rising as companies try to meet targets to cut GHGs, brokers said at an industry conference yesterday. 'The last trade was at seven pounds ($10.48) a tonne,' said Nicola Steen, Vice President of brokers CO2e.com, adding that recent prices had been around six pounds and typical transaction sizes were 5–15 000 tonnes of CO_2 equivalent. Many British firms now have targets to cut their emissions of GHGs from fossil fuel use, such as CO_2, blamed by many scientists for global warming. If they make these targets they can gain carbon allowances to sell under the voluntary UK emissions trading scheme, launched in April. Companies that miss their goal can buy allowances to offset their emissions. Carbon allowances were between three and six pounds in April, though prices are likely to be volatile because of illiquidity. Thirty-four organizations entered the scheme directly, with nearly 6000 other companies expected to join UK trading this year, already holding agreements to cut emissions under the climate change levy scheme, for which they will receive tax rebates on energy use.

Nordic region creates climate fund to reduce emissions

Associated Press
27 June 2002
http://story.news.yahoo.com/news?tmpl=story&u=/ap/20020627/ap_wo_en_po/nordic_pollution_2

The Nordic countries announced the creation of a 10-million euro regional climate fund to cut CO_2 emissions in the Baltic Sea region. Details were released at a regular Nordic Council of Ministers Meeting of the energy ministers from Norway, Sweden, Denmark, Finland, and Iceland. The funds will be invested in reducing CO_2 emissions from the energy sector. Each country will contribute a share to the fund. The ministers called it 'an important step in turning the Barents Sea region into a test area for Kyoto mechanisms.' The 1997 Kyoto Protocol calls on about 40 industrialized nations to limit carbon emissions or to cut them below 1990 levels. It also includes mechanisms including trading quotas for emissions that could allow the Nordic countries to help their neighbours on the Baltic Sea, such as Latvia, Estonia, and Lithuania, cut emissions from their Soviet-era industry. Proponents of quota trading systems say it would be more cost-effective to invest in reducing emissions from old and high-pollution plants than to spend the same amount on reducing carbon dioxide emissions from relatively clean modern power plants and other industries.

Abstracts of recent literature

- Abstracts grouped under four headings
- Every abstract verified against the original source
- Photocopies of original documents available
- All published abstracts (717 records so far) are available for search
- List of source documents consulted for this issue appears below

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Subject

Climate change

- Vulnerability, impacts, and adaptations
- Atmospheric chemistry and meteorology
- GHG emissions and mitigation
- Kyoto mechanisms
- Energy issues and policies
- Global changes: equity, economy, and technology transfer

*Biodiversity**

Natural resources

*Trade and environment**

General

Source documents

Journal	Year, volume, and issue
Ambio	2002: **31**(1)
Bio Energy News	2001: 5(4)
Climate Policy	2001: 1(4), 2002: 2(1)
Current Science	2002: **82**(3), **82**(5)
Ecological Economics	2002: **41**(1), **40**(3)
Energy	2002: 27(2)
Energy and Environment	2002: **13**(1)
Energy Policy	2002: **30**(4), **30**(5), **30**(6), **30**(8), **30**(9)
Environment and Development Economics	2002: 7(2)
International Journal of Energy Technology and Policy	2002: 1(1/2)
Nature	2001: **415**(6871), **416**(6879), **416**(6882)
Proceedings of the National Academy of Sciences of the United States of America	2002: **99**(7), **99**(9)
Science	2002: **296**(5569), **296**(5576)
The Energy Journal	2002: **23**(2)

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* No abstracts on the topic appear in this issue

CLIMATE CHANGE

Vulnerability, impacts, and adaptations

Climate warming and disease risks for terrestrial and marine biota

[410] Infectious diseases can cause rapid population declines or species extinctions. Many pathogens of terrestrial and marine taxa are sensitive to temperature, rainfall, and humidity, creating synergisms that could affect biodiversity. Climate warming can increase pathogen development and survival rates, disease transmission, and host susceptibility. Although most host-parasite systems are predicted to experience more frequent or severe disease impacts with warming, a subset of pathogens might decline with warming, releasing hosts from disease. Recently, changes in El Niño-Southern Oscillation events have had a detectable influence on marine and terrestrial pathogens, including coral diseases, oyster pathogens, crop pathogens, Rift Valley fever, and human cholera. To improve the ability to predict epidemics in wild populations, it will be necessary to separate the independent and interactive effects of multiple climate drivers on disease impact. (3 figures, 82 references)

Harvell C D, Mitchell C E, Ward J R, *et al.* 2002
Science 296(5576): 2158-2162

Department of Ecology and Evolutionary Biology, Cornell University, Ithaca, NY 14853, USA <cdh5@cornell.edu>

Climate change hastens population extinctions

[411] Climate change is expected to alter the distribution and abundance of many species. Predictions of climate-induced population extinctions are supported by geographic range shifts that correspond to climatic warming, but few extinctions have been linked mechanistically to climate change. The authors show that extinctions of two populations of a checkerspot butterfly were hastened by increasing variability in precipitation, a phenomenon predicted by global climate models. The authors model checkerspot populations to show that changes in precipitation amplified population fluctuations, leading to rapid extinctions. As populations of checkerspots and other species become further isolated by habitat loss, climate change is likely to cause more extinction, threatening both species diversity and critical ecosystem services. (8 figures, 42 references)

McLaughlin J F, Hellmann J J, Boggs C L, *et al.* 2002
Proceedings of the National Academy of Sciences of the United States of America 99(9): 6070-6074

Department of Environmental Sciences, Huxley College of the Environment, Western Washington University, Bellingham, WA 98225-9181 <jmcl@cc.wwu.edu>

Interpretation of recent southern hemisphere climate change

[412] Climate variability in the high-latitude SH (southern hemisphere) is dominated by the SH annular mode, a large-scale pattern of variability characterized by fluctuations in the strength of the circumpolar vortex. The authors present evidence that recent trends in the SH tropospheric circulation can be interpreted as a bias toward the high-index polarity of this pattern, with stronger westerly flow encircling the polar cap. It is argued that the largest and most significant tropospheric trends can be traced to recent trends in the lower stratospheric polar vortex, which are largely due to photochemical ozone losses. During the summer-fall season, the trend toward stronger circumpolar flow has contributed substantially to the observed warming over the Antarctic Peninsula and Patagonia and to the cooling over eastern Antarctica and the Antarctic plateau. (4 figures, 3 tables, 54 references)

Thompson D W J and Solomon S. 2002
Science 296(5569): 895-899

Department of Atmospheric Science, Foothills Campus, Colorado State University, Fort Collins, CO 80523, USA <davet@atmos.colostate.edu>

Ecological responses to recent climate change

[413] There is now ample evidence of the ecological impacts of recent climate change, from polar terrestrial to tropical marine environments. The responses of both flora and fauna span an array of ecosystems and organizational hierarchies, from the species to the community levels. The authors assess the observations using a process oriented approach and present an integrated synopsis across the major taxonomic groups, covering most of the biomes on earth. The authors focus on the consequences of 30 years of warming at the end of the 20th century, and review the responses in (1) the phenology and physiology of organisms; (2) the range and distribution of species; (3) the composition of and interactions within communities; and (4) the structure and dynamics of ecosystems, highlighting common and contrasting features amongst the taxa and systems considered. Despite continued uncertainty to community and ecosystem trajectories under global change, the paper attempts to expose a coherent pattern of ecological change across systems. The authors claim that although we are only at the early stage in the projected trends of global warming, ecological responses to recent climate change are already clearly visible. (4 figures, 2 tables, 97 references)

Walther G-R, Post E, Convey P, *et al.* 2002
Nature 416(6879): 389-395

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Atmospheric chemistry and meteorology

Antarctic climate cooling and terrestrial ecosystem response

[414] The average air temperature at the earth's surface has increased by 0.06 °C per decade during the 20th century, and by 0.19 °C per decade from 1979 to 1998. Climate models generally predict amplified warming in polar regions, as observed in Antarctica's peninsula region over the second half of the 20th century. The authors claim that although previous reports suggest slight, recent, continental warming, their spatial analysis of Antarctic meteorological data demonstrated a net cooling on the Antarctic continent between 1966–2000, particularly during summer and autumn. The McMurdo Dry Valleys have cooled by 0.7 °C per decade between 1986–2000, with similar pronounced seasonal trends. Summer cooling is particularly important to Antarctic terrestrial ecosystems that are poised at the interface of ice and water. The authors present data from the dry valleys representing evidence of rapid terrestrial ecosystem response to climate cooling in Antarctica, including decreased primary productivity of lakes (6%–9% per year) and declining numbers of soil invertebrates (more than 10% per year). Continental Antarctic cooling, especially the seasonality of cooling poses challenges to models of climate and ecosystem change. (2 figures, 29 references)

Doran P T, Priscu J C, Lyons W B, *et al.* 2001
Nature 415(6871): 517-51

Department of Earth and Environmental
Sciences, University of Illinois at Chicago, 845
West Taylor Street, Chicago, Illinois 60607,
USA

Vegetation *vis-à-vis* climate and glacial fluctuations of the Gangotri Glacier since the last 2000 years

[415] Pollen analysis of a 1.25 metres sediment profile from an outwash plain at Bhujbas (3800 m asl) near Gangotri Glacier has revealed the vegetational changes in relation to climatic and glacial fluctuations in the area during the past 2000 years. Around 2000 years BP, open *Juniperus–Betula* forest occupied the area vacated by the Glacier, revealing comparatively cooler and moist climate than the one prevailing at present. Subsequent increase of local arboreal taxa (*Juniperus, Betula, Salix*)

and extra local elements (mainly *Pinus*) around 1700 years BP, indicates further amelioration of climate, i.e. increase of both precipitation and temperature in this region. Around 850 years BP there is a shift in the vegetational pattern, with sharp increase in *Ephedra* and other steppe elements notably *Artemisia* and *Asteraceae*. This reflects a trend towards drier climatic conditions, which is also evidenced by a decrease in ferns and *Potamogeton*. During the recent times, the climate again reverted to warm and moist due to the increase in temperature, resulting in the retreat of snout to higher elevations. (5 figures, 19 references)

Kar R, Ranhotra P S, Bhattacharyya A, *et al.* 2002
Current Science 82(3): 347-351

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53 Univeristy Road, Lucknow - 226 007, India

Constraints on radiative forcing and future climate change from observations and climate model ensembles

[416] The assessment of uncertainties in global warming projections is often based on expert judgement, because a number of key variables in climate change are poorly quantified. In particular, the sensitivity of climate to changing GHG concentrations in the atmosphere and the radiative forcing effects by aerosols are not well constrained, leading to large uncertainties in global warming simulations. The authors present a Monte Carlo approach to produce probabilistic climate projections, using a climate model of reduced complexity. The uncertainties in the input parameters and in the model itself are taken into account, and past observations of oceanic and atmospheric warming are used to constrain the range of realistic model responses. The authors obtain a probability density function for the present-day total radiative forcing, giving 1.4–2.4 W/m^2 for the 5%–95% confidence range, and narrowing the global mean indirect aerosol effect to the range of 0 to -1.2 W/m^2. Ensemble simulations for two illustrative emission scenarios suggest a 40% probability that global mean surface temperature increase will exceed the range predicted by IPCC, but only a 5% probability that warming will fall below that range. (3 figures, 29 references)

Knutti R, Stocker T F, Joos F, *et al.* 2002
Nature 416(6882): 719-723

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GHG emissions and mitigation

A Shapley decomposition of carbon emissions without residuals

[417] Traditional decomposition analyses with a limited number of factors still yield important residuals even over short periods of time. Another problem is that the value of the contribution assigned to any given factor depends on the order in which the factors appear in the elimination sequence. Factors that are not treated asymmetrically lead to an important 'path dependence problem'. Especially for analyses over long periods with many variables, high residuals make it almost impossible to derive reliable conclusions. As an alternative, the authors present the Shapley decomposition technique for carbon emissions over the period 1960–1996. This technique makes it possible to present a correct and symmetric decomposition without residuals. The starting point of this analysis was an extended 'Kaya' identity with nine components. In a study of four countries, the Shapley decomposition showed that the carbon intensity of energy use and the decarbonization of economic growth – variables that are targeted with current climate policy measures – have more effect on total emissions than generally suggested in conventional decomposition exercises. Another conclusion from the analysis was

Albrecht J, François D, and Schoors K. 2002
Energy Policy 30(9): 727-736

Faculty of Economics and Business
Administration, Centre for Environmental

that the effect of population growth on emissions could be, for some countries, more important than the decarbonization efforts. (3 tables, 17 references)

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University of Ghent, Hoveniersberg 24, 9000
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Baseline, leakage and measurement issues: how do forestry and energy projects compare?

[418] This paper examines three issues in quantifying project-level emission reductions: baseline and additionality determination, leakage assessment, and measurement of net emissions. It finds no systematic differences between LUCF (land-use change and forestry) and energy projects in addressing these issues. Rather, the ease of quantification depends on (i) the level and distribution of direct financial benefits that result from the project, since this is a key determinant of additionality; (ii) the degree to which the project is integrated with a broader physical and economic system, since this determines the amount of leakage; and (iii) internal homogeneity and geographic dispersion of the project components—a key determinant of measurement costs. These dimensions cut across the energy versus LUCF distinction. (39 references)

Chomitz K M. 2002
Climate Policy 2(1): 35–49

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USA <kchomitz@worldbank.org>

Japanese carbon storage in materials

[419] The NEAT (Non-energy use Emission Accounting Tables) model has been developed in order to estimate CO_2 emissions caused by the so-called non-energy use of fossil fuels. The model is based on material flow accounting. It has been applied to a number of countries in order to validate and improve its use. This paper discusses the case study for Japan. The NEAT analysis suggests that emissions in 1996 were 23 MT higher than previously estimated emissions, based on the IPCC guidelines. This quantity equals 1.9% of the total Japanese GHG emission. It is recommended to adjust the Japanese emission accounting practice and to apply more detailed emission estimation methods in future years. Given similar results for other countries it is also recommended to improve the IPCC guidelines. (4 figures, 7 tables, 30 references)

Gielen D and Yagita H. 2002
Ambio 31(1): 14–20
National Institute for Environmental Studies,
16-2 Onogawa Tsukuba, Ibaraki 305 0053,
Japan <dolf.gielen@nies.go.jp>

Russian methane emissions: options for reduction

[420] This paper provides an account on the estimates of CH_4 emissions from the Russian Federation and a description of the technologies, which can be used to reduce these emissions. It is similar in approach and methodology to previous publications on Russian CO_2 emissions, but extends the focus of that research from power generation to the fuels industries. CH_4 has been chosen for the study, as it is the next most important GHG in terms of volume of emissions after CO_2. Although accounting for only one per cent of the total tonnes of GHGs emitted from the Russian Federation in 1990 (the base year chosen for consequent comparisons in future years by the Kyoto Protocol), the higher global warming potential of CH_4 compared to CO_2 increased its proportion to 18% of the global warming effect of Russian GHG emissions in 1990. Furthermore, the emissions of CH_4 were far in excess of the remaining major GHGs, (namely N_2O [nitrous oxide], SF_6 [sulphur hexafluoride], HFCs

[hexafluorocarbons] and PFCs [polyfluorocarbons]), which although higher in global warming potential than CH_4 only accounted for some four per cent of total Russian GHG emissions in 1990. The reduction of the emissions of these minor GHGs is restricted to a decrease in the use of mineral fertilizers in the case of N_2O, or the substitution of SF_6 and HFCs by other gases. In the case of the reduction of CH_4 emissions, however, a wider range of industries and technologies is involved, and there are also linkages between CH_4 and CO_2 reductions. (1 table, 53 references)

Hill M R. 2002
Energy and Environment 13(1): 57-80

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Greenhouse gas emissions and barriers to implementation in the Jordanian energy sector

[421] In this article a general overview of Jordan's energy sector, possible CO_2 emission reduction options and constraints which would retard the implementation processes, as well as appropriate suggestions for removal of the prevailing barriers are examined. In 1995, Jordan's annual emission of GHGs was approximately 13.8 × 10^6 tonnes, of which the fossil fuels combustion contributed to more than 85%. It is likely that CO_2 emissions, from energy operations, will rise to about 20 × 10^6 tonnes in the year 2010, when the energy consumption will be twice of that in 1995. There are many viable CO_2 mitigation measures identified in the energy sector, some of these can be considered as attractive opportunities. However, their implementation requires the removal or ease of certain obstacles. The latter includes lack of awareness, access to appropriate technology and legislative framework as well as energy pricing policies. (5 figures, 1 table, 23 references)

Jaber J O. 2002
Energy Policy 30(4): 385-395

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A comparison of Nordic energy and CO_2 intensity dynamics in the years 1960–1997

[422] This study is a comparative analysis of energy consumption and CO_2 emission flows in the Nordic countries of Finland, Denmark, Norway, and Sweden from the years 1960 to 1997. The comparative analyses are based on complete decomposition methodology, from which the authors provide an analysis of the dynamic changes of energy consumption and CO_2 emission flows in those Nordic economies. The comparative analysis reveals that (1) the economic activity effects of the different Nordic countries were quite similar, (2) the structural effects varied considerably indicating differences in the relative economic activities in the analysed countries, and (3) the intensity effects on energy use suggest that there were no significant changes in Finland and Sweden during that period. In Denmark and Norway, although intensity effects first increased in the 1960s, they had a downward sloping trend after 1970. The intensity effects of CO_2 emissions increased until the year 1970 and thereafter decreased until the year 1990. In the 1990s, only Norway's intensity effect continued to decrease. In contrast to the other Nordic countries, Finland's CO_2 emission intensity effect differs greatly. It continued to increase until the year 1980, then decreased sharply at the beginning of the 1980s and experienced considerable fluctuations after that. (15 figures, 1 table, 22 references)

Luukkanen J and Kaivo-oja J. 2002
Energy 27(2): 135-150

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Box 110, 20521 Turku, Finland <atjylu@uta.fi>

Integrated assessment of abrupt climatic changes

[423] One of the most controversial conclusions to emerge from many of the first generation of IAMs (integrated assessment models) of climate policy was the perceived economic optimality of negligible near-term abatement of GHGs. Typically, such studies were conducted using smoothly varying climate change scenarios or impact responses. Abrupt changes observed in the climatic record and documented in current models could substantially alter the stringency of economically optimal IAM policies. Such abrupt climatic changes – or consequent impacts – would be less foreseeable and provide less time to adapt, and thus, would have far greater economic or environmental impacts than gradual warming. The authors extend conventional, smooth IAM analysis by coupling a climate model capable of one type of abrupt change to a well-established energy-economy model called DICE. The authors compare the DICE optimal policy using the standard climate sub-model with their version that allows for abrupt change – and consequent enhanced climate damage – through changes in the strength (and possible collapse) of the North Atlantic THC (thermohaline circulation). The authors confirm the potential significance of abrupt climate change to economically optimal IAM policies, thus calling into question all previous works neglecting such possibilities—at the least for the wide range of relevant social and climate system parameters considered by the authors. In addition, the authors obtained an emergent property of their coupled social-natural system model: 'optimal policies' that do consider abrupt changes may, under relatively low discount rates, calculate emission control levels sufficient to avoid significant abrupt change, whereas 'optimal policies' disregarding abrupt changes would not prevent this non-linear event. However, there is a threshold in discount rate above which the present value of future damages is so low that even very large enhanced damages in the 22nd century, when a significant abrupt change such as a THC collapse would be most likely to occur, do not increase optimal control levels sufficiently to prevent such a collapse. Thus, any model not accounting for potential abrupt non-linear behaviour and its interaction with the discounting formulation is likely to miss an important set of possibilities relevant to the climate policy debate. (4 figures, 3 tables, 46 references)

Mastrandrea M D and Schneider S H. 2001
Climate Policy 1(4): 433-449

Department of Geological and Environmental Sciences, Stanford University, Stanford, CA 94305, USA <mikemas@stanford.edu>

Emission of carbon dioxide from soil

[424] Carbon dioxide is an important GHG, accounting for 60% of the total GHG effect. Soil is a major source for atmospheric CO_2. In the event of growing threats of global warming due to GHG emissions, reducing CO_2 emission by sequestering carbon in the soil is of prime importance. The objectives of this article are to review the research on (1) emission of CO_2 from the soil and the effect of various factors regulating the emission, (2) emission of CO_2 from different ecosystems, and (3) to suggest measures to increase the sink of CO_2 through carbon sequestration in the soil. Soil management practices like increasing soil organic carbon content, reduced tillage, manuring, residue incorporation, improving soil biodiversity, micro-aggregation, and mulching can play important roles in sequestering carbon in soil. (2 figures, 2 tables, 91 references)

Rastogi M, Singh S, and Pathak H. 2002
Current Science 82(5): 510-517

Division of Environmental Sciences, Nuclear Research Laboratory Building, Indian Agricultural Research Institute, New Delhi - 110 012 <him_ensc@iari.ernet.in>

Atmospheric carbon dioxide levels for the last 500 million years

[425] The last 500 million years of the strontium-isotope record are shown to correlate significantly with the concurrent record of isotopic fractionation between inorganic and organic carbon after the effects of recycled sediment are removed from the strontium signal. The correlation is shown to result from the common dependence of both signals on weathering and magmatic processes. Because the long-term evolution of CO_2 levels depends similarly on weathering and magmatism, the relative fluctuations of CO_2 levels are inferred from the shared fluctuations of the isotopic records. The resulting CO_2 signal exhibits no systematic correspondence with the geologic record of climatic variations at tectonic time scales. (4 figures, 32 references)

Rothman D H. 2002
Proceedings of the National Academy of Sciences of the United States of America
99(7): 4167-4171

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<dan@segovia.mit.edu>

Differentiation of mitigation commitments: the multi-sector convergence approach

[426] This paper presents a new sector-based framework called the multi-sector convergence approach, for negotiating binding national GHG mitigation targets after the first budget period defined by the Kyoto Protocol (2008–12). The major characteristics of this approach are that (1) it is based on the distinction of different sectors within the national economy; (2) it prescribes that, in principle, the amount of per capita emission assignments should ultimately converge to the same level for all countries; (3) it accounts for differences in national circumstances by offering the opportunity to grant additional emission allowances to countries facing specific circumstances that justify higher emission assignments; and (4) it offers a framework for negotiating mitigation commitments among the Parties of UNFCCC, including a gradual participation of the developing countries that pass a certain threshold level of per capita emissions. In addition to briefly discussing the underlying principles of promising proposals to differentiate future GHG mitigation commitments, the paper outlines the methodology and major characteristics of the MSC (multi-sector convergence) approach, followed by some numerical illustrations. The paper is concluded by a preliminary assessment of the MSC approach. (3 figures, 5 tables, 19 references)

Sijm J, Jansen J, and Torvanger A. 2001
Climate Policy 1(4): 481-497

Energy Research Centre of The Netherlands, Policy Studies, PO Box 37154, 1030 AD Amsterdam, The Netherlands <sijm@ecn.nl>

Kyoto mechanisms

Technology transfer under the CDM – materializing the myth in the Japanese context?

[427] The paper investigates the role that CDM could play in enhancing the effectiveness of the north-south technology transfer. This is done by first exploring the issue of technology transfer in the context of existing north-south experiences to bring out the basis for the poor and unsatisfactory performance. This is followed by bringing out the intrinsic relevance of appropriate technology transfer for combating the global climate change issue. The paper then analyses the potential for such an appropriate and sustainable transfer, as well as effective diffusion and deployment of technologies under CDM. Various aspects of the evolving design of CDM are investigated to analyse the potential for overcoming the historical barriers across the North-South divide. Any potential for technology transfer under CDM would need to be

supported by an effective framework in the developed countries as well as a conducive environment in developing countries. In searching for such a cooperative and complementary model, the paper analyses the current Dutch strategy to bring forth certain salient features that could be applicable for other countries. Finally, a Japanese model for technology transfer is developed which can build upon domestic strengths like adopting applicable features of the Dutch strategy to capitalize any latent potential under CDM. This is done by first investigating the effectiveness of the existing Japanese technology transfer framework and then extending recommendations for adapting it to reflect the shifting resource flow paradigms under the climate change regime. (3 figures, 5 references)

Aslam M A. 2001
Climate Policy 1(4): 451-464

ENVORK: A Research and Development
Organization, House 7, Street 30, F-7/1,
Islamabad, Pakistan<aminsb.comsats.net.pk>

Tradeable carbon permit auctions: How and why to auction not grandfather

[428] An auction of carbon permits is the best way to achieve domestic carbon caps designed to limit global climate change. To minimize administrative costs, permits would be required at the level of oil refineries, natural gas pipelines, natural gas liquid sellers, and coal processing plants. To maximize liquidity in secondary markets, permits would be fully tradable and bankable. The government would conduct quarterly auctions. A standard ascending-clock auction in which price is gradually raised until there is no excess demand would provide reliable price discovery. An auction is preferred to grandfathering (giving companies permits based on historical output or emissions), because it allows reduced tax distortions, provides more flexibility in distribution of costs, provides greater incentives for innovation, and reduces the need for politically contentious arguments over the allocation of rents. (3 figures, 1 table, 46 references)

Cramton P and Kerr S. 2002
Energy Policy 30(4): 333-345

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19 Milne Tce, Island Bay, Wellington,
New Zealand <ker@motu.org.nz>

A qualitative method to consider leakage effects from CDM and JI projects

[429] Indirect effects (leakage) are an important issue in baseline development for the CDM and the JI projects but so far no coherent methodology for their determination has been suggested. The authors propose a simplified method to correct direct emission reduction values for leakage. A matrix of different project types should be elaborated that shows leakages in qualitative form. Depending on the number of entries in the matrix columns, an overall leakage factor will be calculated by summing up factors related to the cell entries. The factors have predetermined values denominated in per cent to cover the different qualitative degrees of leakage. (1 table, 6 references)

Geres R and Michaelowa A. 2002
Energy Policy 30(6): 461-463

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Benchmark-based emission allocation in a cap-and-trade system

[430] One of the important bottlenecks for the introduction of emission trading is how allowances should be distributed among the participants in a trading scheme. Both grandfathering on the basis of historic emissions and auctioning have important drawbacks. Benchmarking-based allocation provides an appealing alternative to auctioning or grandfathering based on historical emissions. It does not require participants to pay for emission

rights beforehand, as in an auctioning system, which may facilitate the introduction of a trading system. In this paper, the authors propose an allowance distribution rule based on benchmarking of production processes: each company's share in the total allowance is determined by its production level and a reference emission level per product. The scheme shows some important advantages compared to other schemes. (13 references)

Groenenberg H and Blok K. 2002
Climate Policy 2(1): 105-109

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Absolute or relative baselines for JI/CDM projects in the energy sector?

[431] The two project-based Kyoto mechanisms, the JI and the CDM, require a determination of the baseline, the development of GHG emissions in the absence of the project. This paper examines, whether absolute (given in tonnes of CO_2 equivalent) or relative baselines (benchmarks given, e.g., in tonnes of CO_2 equivalent/MWh) should be applied for JI/CDM projects in the energy sector. Accuracy of the GHG emission reduction and manageability of GHG emission balances are used as evaluation criteria. The results show that relative baselines are a more accurate instrument for the estimation of emission reductions in JI/CDM projects in the energy sector without posing significant additional risks to the management of GHG emission balances for large entities. In comparison to absolute baselines, relative baselines indicate in a more realistic and conservative manner the amount of emission reductions obtained in the energy system and give more appropriate incentives to project sponsors. The additional risks of relative baselines are likely to be small compared to the normal deviation of the domestic/internal GHG emissions. The findings are in line with the Marrakesh Accords, which set restrictions to application of absolute baselines.
(2 figures, 4 tables, 25 references)

Laurikka H. 2002
Climate Policy 2(1): 19-33

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Climate change and clean development mechanism

[432] From the UNFCCC at Rio in 1992 to the meeting of the COP (Conference of the Parties) at Marrakesh in November 2001, debate on climate change has travelled a long distance. In between, the COP in its third meeting at Kyoto in Japan produced the Kyoto Protocol containing commitments by developed countries to reduce GHG emissions. It also included three mechanisms to facilitate the emissions reduction, including CDM. CDM can be expected to benefit both developed and developing countries through opportunities for additional investment and transfer of efficient technologies to the former, and reduced cost of emissions reduction in the latter. The CDM market has, however, received a setback after the withdrawal of the US from the Kyoto Protocol. Modalities to put CDM into operation have now been spelled out in the last COP meeting at Marrakesh, and CDM market can be expected to take-off.
(5 references)

Painuly J P. 2001
Bio Energy News 5(4): 7-10

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Clean development mechanism – an introduction

[433] The CDM is one of several flexibility mechanisms authorized in the December 1997 Kyoto Protocol to the 1992 UNFCCC. The Kyoto Protocol specified legally binding commitments by most industrialized countries (listed Annex B to the Protocol documents) to reduce their collective GHG emissions by at least five

per cent below the 1990 levels by the period 2008–12. With the goal of reaching these targets at the lowest possible cost for countries that committed to reductions, the Protocol created three flexibility mechanisms—emissions trading, JI, and CDM. This article introduces CDM's purpose, mandate and institutional structure as authorized in the Kyoto Protocol and developed through negotiations that culminated at COP-7 in Marrakesh. Further, the article discusses principal technical and administrative issues in implementing the mechanism. CDM is expected to speed up the process of technological change in developing country economies. (1 figure, 4 references)

Sharma S. 2001
Bio Energy News 5(4): 11–14

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Vasant Vihar, New Delhi - 110 057

Why should emissions trading be restricted?

[434] The possibility of using flexibility mechanisms as a way to achieve national commitments under an international agreement to reduce climate gases has been a hot issue throughout the negotiating process of the Kyoto Protocol. A variety of arguments either in favour of or against emissions trading have been put forward by different Parties and by different groups. The purpose of this viewpoint is to look further into the various arguments opposing emissions trading or favouring their restriction (which are really arguments that could be used against all the different flexibility mechanisms) and comment on their validity. (18 references)

Westskog H. 2002
Climate Policy 2(1): 97-103

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Blindern, N-0318 Oslo, Norway
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Energy issues and policies

Options for differentiation of future commitments in climate policy: how to realize timely participation to meet stringent climate goals?

[435] This paper aims at exploring options for differentiation of future commitments in global GHG emissions control, linked to climate targets. This is done on the basis of the EU target of a maximum global temperature increase of 2 °C compared to pre-industrial levels. The Framework to Assess International Regimes for the differentiation of commitments is used to explore the implications of two possible climate regimes: (1) increasing participation (i.e. a gradual increase in the number of parties involved and their level of commitment according to participation and differentiation rules), and (2) contraction and convergence with universal participation and a convergence of per capita emission permits. It is found that in a regime of increasing participation, stabilizing the CO_2 concentration at 450 ppmv by 2100 requires participation of major developing countries before 2050 in global emission control, irrespective of the participation and differentiation rules chosen. In the case of stringent climate targets, a convergence regime seems to provide more incentives for a timely participation of developing countries, and opportunities for an effective and efficient regime for controlling global emissions than increasing participation. (8 figures, 31 references)

Berk M M and den Elzen M G J. 2001
Climate Policy 1(4): 465-480

Netherlands National Institute for Public
Health and the Environment, PO Box 1, 3720
BA Bilthoven, The Netherlands

Climate policy and dynamic efficiency gains – a case study on Norwegian CO_2 taxes and technological innovation in the petroleum sector

[436] Against increasing scientific evidence of human-induced global warming, and prevailing uncertainties regarding the fate of the

Kyoto Protocol, the use of environmental taxes has been gaining increasing popularity in the OECD region. Economists often conjecture that such instruments provide a continuous incentive for technological innovation, which is likely to be a key determinant for success or failure in the climate policy, at least in the long turn. However, there is little empirical evidence available to justify claims of that kind. The objective of this paper is to provide such evidence, by assessing the impacts of Norwegian CO_2-taxes, the key instrument in Norway's climate policy, on technological innovation in upstream petroleum operations. The balance of evidence suggests that the introduction of CO_2-taxes has provided some incentive for innovation that has shifted petroleum operations in a less emission-intensive direction. That said, the pattern of technological change pertains mostly to incremental process innovations, cumulative improvements, and adaptations of technologies already available. These insights may assist policy-makers when formulating policy strategies and selecting instruments for climate change mitigation. (4 figures, 6 references)

Christiansen A C. 2001
Climate Policy 1(4): 499-515

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<atle.christiansen@fni.no>

Magnitude, distribution and causes of terrestrial carbon sinks and some implications for policy

[437] Recent analyses continue to modify our understanding of terrestrial carbon sinks. The sinks are large and variable enough to account for much of the variability in the growth rate of atmospheric CO_2. They are distributed throughout both northern mid-latitudes and the tropics. Identification of the factors influencing an observed sink is extremely difficult; methods for attribution are reviewed. Although various ecological mechanisms (e.g. CO_2 fertilization, nitrogen deposition, climatic variability) have been shown experimentally to have short-term effects on physiological processes controlling the amount of carbon in terrestrial ecosystems, it is unclear which of these mechanisms has been most important in the past 10–100 years and which will be most important in the future. The decades-long supposition that CO_2 fertilization has been a major driver of terrestrial carbon uptake is being challenged. A major portion of the sink in the northern mid-latitudes (although probably not in the tropics) is a result of recovery from past changes in land use and management. To the extent that these direct human actions explain most of the current (and future) sink, attribution and thus accounting become more tractable, but the continued functioning of the sink is limited and largely dependent on deliberate actions like afforestation, sustainable forest management and preservation. (1 figure, 7 tables, 59 references)

Houghton R A. 2002
Climate Policy 2(1): 71-88

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<rhoughton@whrc.org>

Renewable energies in electricity generation for reduction of greenhouse gases in Mexico 2025

[438] This study presents four scenarios relating to the environmental futures of electricity generation in Mexico up to the year 2025. The first scenario emphasizes the use of oil products, particularly fuel oil, and represents the historic path of Mexico's energy policy. The second scenario prioritizes the use of natural gas, reflecting the energy consumption pattern that arose in the mid-1990s as a result of reforms in the energy sector. In the third scenario, the high participation of renewable sources of

energy is considered feasible from a technical and economic point of view. The fourth scenario takes into account the present- and medium-term use of natural gas technologies that the energy reform has produced, but after 2007 a high and feasible participation of renewable sources of energy is considered. The four scenarios are evaluated up to the year 2025 in terms of GHGs and ARPGs (acid rain precursor gases). (5 figures, 4 tables, 16 references)

Isias J, Manzini F, and Martinez M. 2002
Ambio 31(1): 35-39

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<jis@mazatl.cie.unam.mx>

Primary energy needs and greenhouse effect increase: what can be done?

[439] The primary energy needs are estimated to grow by a factor of 2.3 from now to 2050. At the same time, the necessary reduction of CO_2 emissions may lead to a drastic cut in the use of fossil fuels. To avoid an energy shortage, a very large share of energy production has to be met by renewable energies or nuclear energy. These two kinds of energy have specific environmental impacts and constraints, which are briefly discussed. A significant contribution of renewable energies implies that large land areas and a good energy storage technology are available while nuclear energy cannot be sufficiently extended using the present PWR reactor technology. Using an optimized new option for energy production, it is shown that nuclear energy can provide a significant share of energy needs. The authors point out that this no longer the time to discuss which energy has to be developed, but to develop both at the appropriate significantly increased production level. (2 tables, 3 references)

Loiseaux J-M. 2002
International Journal of Energy Technology and Policy 1(1 and 2): 27-36

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des martyrs, 38026 Grenoble Cedex, France
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What will happen to the producer prices for fossil fuels if Kyoto is implemented?

[440] Implementation of the Kyoto commitments will result in lesser global fossil fuel consumption in 2010 than would occur in the absence of climate policy. The paper explores how the consumption change resulting from climate policy implementation could affect the producer prices of fossil fuels. The issue under investigation is of importance not only to climate policy implementation. Another important consideration is the well being of the fossil producing industries and fossil exporting countries. The resource rents reaped by these industries and countries will be clearly reduced if the demand declines. These rents will be reduced even more if, at the same time, the price is suppressed below what it would have been otherwise. The conclusion is that the price impact will be insignificant if the climate policy goals are established credibly in the near future, for that will give rationally behaving fossil fuel producers ample time to adjust production capacity to the changed outlook for future demand. It is argued that as long as capacity develops in line with the demand, prices should remain the same, irrespective of the speed and direction of the change in demand. (1 figure, 4 tables, 21 references)

Radetzki M. 2002
Energy Policy 30(5): 357-369

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Precautionary climate policy and the somewhat flawed protocol: linking sinks to biofuel and the CDM to the convention

[441] Flaws in the Kyoto Protocol are obscured by claims of unfairness, with Annex 1 Parties committed to taking the lead. Similarly the precautionary measures required can have the same

effect by the Rio Convention, ratified by the US Senate, *nem. con.* Such measures should be cost-effective, invalidating the use of Kyoto Protocol supplementarity to enforce a narrow concept of domestic action that neglects low cost preparedness to respond quickly to bad scientific news, e.g., regarding thresholds for runaway climate change processes. Carbon capture and sequestration, along with bio-energy, enable a low, possibly negative, emissions carbon fuel system, avoiding the costly premature obsolescence of existing infrastructure. For convergence after 2012 between Kyoto Parties and non-Kyoto Annex 1 Parties, it is suggested to link low-cost sinks, particularly energy plantations, to biofuel utilization that can drive uptake of renewable liquid fuel technology, cut net emissions fast, reduce dependence on the Middle East oil, stimulate development in many land rich but otherwise impoverished economies, and hopefully provide a basis, through broadening of the CDM. (10 references)

Read P. 2002
Climate Policy 2(1): 89-95

Department of Applied and International Economics, Massey University, Private Bag 11222, Palmerston North, New Zealand <pread2@attglobal.net>

Escaping carbon lock-in

[442] The paper explores the climate policy implications of the arguments made by the same author in an earlier study titled 'Understanding carbon lock-in' (Unruh, 2000), which argued that industrial countries have become locked-into fossil fuel-based energy systems through path dependent processes driven by increasing returns to scale. Carbon lock-in arises through technological, organizational, social and institutional co-evolution, culminating in what was termed as TIC (techno-institutional complex). In order to resolve the climate problem, an escape from the lock-in condition is required. However, due to the self-referential nature of TIC, escape conditions are unlikely to be generated internally and it is argued that exogenous forces are probably required. (1 figure, 1 table, 70 references)

Unruh G C. 2002
Energy Policy 30(4): 317-325

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The oil industry and climate change: strategies and ethical dilemmas

[443] This paper explores the different climate change strategies chosen by three major multinational oil corporations: ExxonMobil, TotalFinaElf and BP Amoco. They are referred to, as the fight against emission constraints, wait and see, and proactive strategies, respectively. The justifications given to support these strategies are identified. They cover the business, scientific, political, economic, technological, and social dimensions. In a business ethics framework, the issue of climate change brings forth an ethical dilemma for the oil industry, in the form of a tension between profits and CO_2 emissions. The strategies are analysed as three attitudes towards this dilemma: (1) placing priority on the business consequences while weakening the perception that anthropogenic GHG emissions are causing climate change; (2) avoiding responsibility; and (3) placing priority on the need for a modification of the business process while limiting the negative effect in terms of business consequences. In conclusion, the authors propose that beyond the ethical issues proper to climate change itself, additional ethical issues are raised if society at large is instrumentalized by an industry in its search for profit. Publicly gauging and valourizing the ethical commitment of a corporation appear as ways of inducing more collaborative and proactive attitudes by business actors. (1 figure, 30 references)

van den Hove S, Menestrel M L, and de Bettignies H-C. 2002
Climate Policy 2(1): 3-18

MEDIAN, Passeig Pintor Romero 8, 08197 Valldoreix, Spain <s.vandenhove@terra.es>

The curious role of 'learning' in climate policy: should we wait for more data?

[444] Given the large uncertainties regarding potential damages from climate change and the significant but also uncertain costs of reducing GHG emissions, the debate over a policy response is often framed as a choice of acting now or waiting until the uncertainty is reduced. Implicit in the *wait to learn* argument is the notion that the ability to learn in the future necessarily implies that less restrictive policies should be chosen in the near term. The author demonstrates in the general case that the ability to learn in the future can lead to either less restrictive or more restrictive policies today. He also shows that the initial decision made under uncertainty will be affected by future learning only if the actions taken today change the marginal costs or the marginal damages in the future. Results from an intermediate-scale integrated model of climate and economics indicate that the choice of current emissions restrictions is independent of whether or not uncertainty is resolved before future decisions, because, like most models, the cross-period interactions are minimal. With stronger interactions, the effect of learning on initial period decisions can be more important. (1 figure, 5 tables, 42 references)

Webster M. 2002
The Energy Journal 23(2): 97-119

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<mort@email.unc.edu>

Domestic climate policies and the WTO

[445] This paper discusses carbon/energy taxes, subsidies, energy efficiency standards, eco-labels and government procurement policies, and explores the potential interaction between these domestic climate policies and the WTO rules. It highlights their potential conflicts, and argues that such conflicts can be avoided or at least minimized if the WTO rules are carefully scrutinized, and efforts are made early to ensure that the proposed climate policies comply with them. The paper suggests an early process of pursuing consultations between the WTO members and the Parties to the UNFCCC and points to the need of further exploring ways to enhance synergies between the trade and climate regimes. (2 tables, 53 references)

Zhang Z X and Assunção L. 2001
Climate Change Modelling and Policy Paper
91.2001: 28 pp.

Research Program, East-West Center, 1601
East-West Road, Honolulu, HI 96848-1601,
USA<ZhangZ@EastWestCenter.org>

Global changes: equity, economy, and technology transfer

Climate politics from Kyoto to Bonn: from little to nothing

[446] In this paper the author investigates how the US withdrawal from the Kyoto Protocol, the provisions of the Bonn climate policy conference on sink credits, and emissions trading would change the economic and environmental impacts of the Protocol in its original form. Based on simulations with a large-scale computable general equilibrium model, the author finds that the US withdrawal and amendments of Bonn reduce the Kyoto Protocol's impact to business-as-usual without binding emissions constraints. On the other hand, compliance of the US under the new Bonn provisions, would accommodate a substantial cut in global emissions at relatively small compliance costs for OECD countries. (9 tables, 18 references)

Böhringer C. 2002
The Energy Journal 23(2): 51-71

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On the consequences of the US withdrawal from the Kyoto/Bonn Protocol

[447] The dynamics of climate change negotiations has recently received new impulses. After the US decided to withdraw from the

Kyoto Protocol, the remaining Annex B Parties reached a compromise on the climate treaty at the resumed COP-6 in Bonn, July 2001. The outcome of the Bonn negotiations has been interpreted as a commitment to the approach embodied by the Kyoto Protocol. Nevertheless, after the first euphoria has passed, it became clear that even after the Bonn Agreement, there still remain a lot of open questions. Some of them have been answered at COP-7 in Marrakesh, but still a lot has to be done. This paper focuses on some strategic reactions that could follow the US defection from the Kyoto/Bonn Protocol. In particular, this paper, by using a model in which technical change is endogenous and responds to environmental policies, will quantify the changes of R&D, emission-output ratio and investments implied by the US decision to withdraw from the Kyoto Protocol. These changes – and the related impact on the demand and supply of permits – will provide additional explanations on why the price of permits and abatement costs are not going to be markedly lowered by the US defection. Finally, robbed of its expected gains of the 'hot air' sales, Russia could be tempted to leave the Kyoto/Bonn Agreement. The authors also explore this scenario in which, as expected, the permit price is going to be dramatically higher because of the absence of the main supplier in the permit market. As a consequence, abatement costs in Annex B-1 regions would be much higher. This scenario explains, more than other legal aspects, the increasing bargaining power of Russia in climate negotiations and the consequent outcomes observed in Marrakesh. (7 figures, 7 tables, 32 references)

Buchner B, Carraro C, and Cersosimo I. 2001
Climate Change Modelling and Policy Paper
102.2001: 29 pp

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Venice, San Giobbe 873, 30121 Venice, Italy
<ccarraro@unive.it>

Constraints to implementing international agreements: the case of the Montreal Protocol in Botswana

[448] This study addresses the difficulties surrounding effective implementation of the Montreal Protocol in Botswana and provides a general understanding of how best we might advise policy-makers when implementing international agreements in the developing world. A questionnaire survey administered to both the formal and informal users of ODSs (ozone depleting substances) revealed that disseminated information on ODSs has little effect on choices that users make about refrigerant gases and this information is skewed in favour of the conventional users of ODSs. As a result, annual statistics of ODS use are probably underestimated. Difficulties exist in changing from old to new technologies in the short term due to high costs associated with the changeover. The infrastructure to recover gases and to dispose of unusable hardware is absent or inadequate. Solutions to these difficulties include a comprehensive policy that caters for all users of ODSs and the integration of economic and environmental aspirations. (5 figures, 27 references)

Chipanshi A C. 2002
Ambio 31(1): 30-34

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Causality between income and emission: a country group-specific econometric analysis

[449] Empirical studies of the EKC (Environmental Kuznets Curve) examine the presence or otherwise of an inverted U-shaped relationship between the level of pollution and the level of income. Customarily, in the diagram of EKC the level of income is shown on the horizontal axis and that of pollution on the vertical axis. Thus, it is presumed that the relationship between income

and pollution is one of unidirectional causality with income causing environmental changes and not vice versa. The validity of this presumption is now being questioned. It is being asserted that the nature and direction of causality may vary from one country to the other. In this paper, the authors present the results of a study of income-CO_2 emission causality, based on a Granger causality test to cross-country panel data on per capita income and the corresponding per capita CO_2 emission data. Briefly, the results indicate three different types of causality relationship holding for different country groups. For the developed country groups of North America and Western Europe (and also for Eastern Europe) the causality is found to run from emission to income. For the country groups of Central and South America, Oceania and Japan causality from income to emission is obtained. Finally, for the country groups of Asia and Africa the causality is found to be bidirectional. The regression equations estimated as part of the Granger causality test further suggest that for the country groups of North America and Western Europe the growth rate of emission has become stationary around a zero mean, and a shock in the growth rate of emission tends to generate a corresponding shock in the growth rate of income. In contrast, for the country groups of Central and South America, Oceania and Japan a shock in the income growth rate is likely to result in a corresponding shock in the growth rate of emission. Finally, causality being bidirectional for the country groups of Asia and Africa, the income and the emission growth rates seemed to reinforce each other. (5 tables, 33 references)

Coondoo D and Dinda S. 2002
Ecological Economics 40(3): 351-367

Economic Research Unit, Indian Statistical Institute, 203 B.T. Road, Kolkata 35, India
<dcoondoo@isical.ac.in>

Evaluating the Bonn-Marrakesh Agreement

[450] The paper evaluates the environmental effectiveness and economic efficiency of the Kyoto Protocol after the Bonn Agreement and the Marrakesh Accords. The US withdrawal has by far the greatest impact in reducing the environmental effectiveness, lowering the price of traded emission permits and reducing Annex I abatement costs. The decisions on sinks imply that the CO_2 equivalent emissions of Annex I Parties without the US will come out at about half per cent instead of over four per cent below base-year level. Without US participation, the emission permit price is estimated to be low. Therefore, banking hot air by Russia and Ukraine is of absolute importance for the development of a viable emissions trading market and would also enhance the environmental effectiveness of the Kyoto Protocol. (3 figures, 1 table, 13 references)

den Elzen M G J and de Moor A P G. 2002
Climate Policy 2(1): 111-117

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Time preference in global warming calculations: a proposal for a unified index

[451] Many aspects of the calculation of the impacts of GHG emissions and the costs and benefits of possible response options are highly sensitive to the way in which time preference is incorporated into the computations. The IPCC used global warming potentials to standardize inputs of different gases with differing radiative forcings and atmospheric lifetimes; in the results emphasized by the IPCC's Second Assessment Report, a 100-year time horizon and no discounting is used, and this has been adopted by the Kyoto Protocol for use in the first commitment

period (2008–12). Here an alternative unified index is proposed that assigns explicit weights to the interests of different generations. In contrast to discounting (including the zero discount rate used by IPCC), the generationally weighted index forces policy-makers to face the moral assumptions that underlie their choices related to global warming.

Fearnside P M. 2002
Ecological Economics 41(1): 21-31

Coord. de Pesquisas em Ecologia, National
Institute for Research in the Amazon, Caixa
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Analysis of a commitment period reserve at national and global levels

[452] To reduce the risk of overselling in the context of international GHG trading under the Kyoto Protocol, the Parties have agreed to a commitment period reserve requirement. The commitment period reserve requires each Annex B Party to hold in its national registry quota equal to the lower of (1) X% of five times the Party's most recently reviewed emissions inventory; and (2) Y% of the Party's initial assigned amount. The agreement reached at the resumed COP-6 sets X=100% and Y=90%. This paper analyses different specifications (values of X and Y) of the commitment period reserve in terms of potential non-compliance due to overselling and restricted sales of quota surplus to compliance needs of the seller. To eliminate potential non-compliance due to overselling, Y must be equal to 100% and X must be greater than 105%. Specifications that limit potential non-compliance due to overselling, may temporarily restrict sales of quota surplus to the compliance of some countries. The Annex II Parties are less likely to face restrictions on sales of surplus quota than other Annex B countries. The risk of temporarily restricted sales is reduced to less than 10% for almost all countries for a value of X close to 90%. (4 figures, 3 tables, 12 references)

Missfeldt F and Haites E. 2002
Climate Policy 2(1): 51-70

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Environment, Riso National Laboratory,
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<fanny.missfeldt@risoe.dk>

Mitigating global warming: traditional versus alternative approaches in a planning versus a market context

[453] Economic efficiency tends to be an important argument when different means of environmental control are assessed and suggested. Considering that the most cost-efficient means are not the ones most frequently chosen and used, some other qualities seem to play an equally important role. The author uses the findings from organizational and negotiation theories to understand better what is concealed in the black box of decision-making and implementation. The empirical material consists of case studies of four different means of environmental control – an environmental tax, a licensing trial, municipal energy planning, and technology procurement – used in Sweden during the 1990s to mitigate the threat of global warming. Each represents a particular discipline (economic, legal, physical planning, or technological) in which a context (planning or market) and an approach (traditional relay race or alternative process-oriented) are combined. Although each means has its particular niche, some qualities stand out as superior. Such means need to be divisible in space as well as in time. It is then easier to get started. Since it is just as easy to deviate from, rather than adhere to, the predetermined course after a while, some incentive must be given to the person in charge of implementation. In other words, the classic proverb of using sticks and carrots is still valid although it is not always taken to heart and practised. (5 figures, 44 references)

Olerup B. 2002
Energy Policy 30(8): 709-716

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Management, Royal Institute of Technology,
SE-100 44 Stockholm, Sweden
<brita.olerup@telia.com>

Ozone dynamics and deposition processes at a deforested site in the Amazon basin

[454] The goal of this study is to investigate the impact of deforestation on ozone dynamics and deposition in the Brazilian Amazon basin. This goal is accomplished through (1) analysis of ozone levels and deposition rates at a deforested site during the rainy season; and (2) comparison of these data with similar information derived at a forest. At the pasture site maximum ozone mixing ratios reach 20 ppbv (parts per billion on a volume) basis but about 6 ppbv prevail over the forest. Maximum ozone deposition velocities for pastures can reach 0.7 cm/s, which is about threefold lower than the values derived for forests. Combining ozone abundance and deposition velocities, pasture maximum ozone fluxes reach ~0.2 mg (ozone)/m^2/s^1. This flux represents approximately 70% of the deposition rates measured over the forest. Hence, this study suggests that conversion of rainforests to pastures could lead to a net reduction (30%) in the ozone sink in the Amazon. (7 figures, 1 table, 34 references)

Sigler J M, Fuentes J D, Heitz R C, *et al.* 2002
Ambio 31(1): 21-27

Department of Environmental Sciences, Clark Hall, Charlottesville, University of Virginia, VA 22903, USA <jf6s@unix.mail.virginia.edu>

Influence of national governments for or against the entry into force of the Kyoto Protocol: a Banzhaf index analysis

[455] The recent announcement by the USA to withdraw their support for the Kyoto Protocol has drawn attention to the conditions under which the Protocol will enter into force: at least 55 member states to the UNFCCC have to ratify the Protocol, and those industrialized countries (Annex I Parties) that ratify it have to make up for at least 55% of the carbon dioxide emissions of this group in 1990. In this article, the authors analyse the priori decision-making power of individual parties, or groups of these, for the Kyoto Protocol to come into force, using a mathematical approach known as the Banzhaf index. The results of the analysis suggest that the conditions for the entry into force of the Kyoto Protocol give more influence to the US than might have been anticipated. It also suggests that while the US has more voting power than the relative share of emissions, all other Annex I Parties have less. Based on a mathematical model, this analysis shows that the Banzhaf index is a more realistic indicator of voting power than the bare numbers fixed in the Kyoto Protocol. This method could be used more extensively in future for the analysis of voting procedures, in particular within the UNFCCC. (6 references)

Wagner F and Höhne N. 2001
Climate Policy 1(4): 517-520

ECOFYS Energy and Environment, Eupener Straße 161, 50933 Köln, Germany <n.hoehne@ecofys.de>

Gender angle to the climate change negotiations

[456] The South is likely to suffer more from climate change than the North due to its already vulnerable situation and the lack of necessary resources to adapt to change. This paper attempts to establish whether gender issues need to be addressed in the climate change debate. Towards this goal, a number of different issues within the climate change debate, in particular, the instruments proposed, are analysed. These include responsibility for emission of GHGs, studies on vulnerability to the effects of climate change, mitigation of emissions, capacity building for participation in flexible mechanisms, and adaptation to climate change. The authors conclude that while there are many gender angles related to the climate change convention and the instruments therein, some are more strategic than others. There is

little to be gained by looking at the responsibility for emissions on a gendered basis. But in mitigation activities, CDM, capacity building, technology transfer, vulnerability studies and projects for adaptation, the poor (the majority of whom are women), should be targeted and made as active participants in decision-making. (8 references)

Wamukonya N and Skutsch M. 2002
Energy and Environment 13(1): 115-129

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NATURAL RESOURCES

Green accounting using imperfect, current prices

[457] The natural resources and the environment are not optimally managed, especially in the developing countries. Even so, it is possible for green accounts based on current prices to measure the realized contributions of the environment to net product. The prices for use in the green accounts, however, are not necessarily shadow prices as would be recommended by cost-benefit analysis: in practice, green or comprehensive net national product is an approximation of an index of welfare. The fact that a linearization of generalized national income is used implies that disaggregated, partial-equilibrium models of resources are useful. (12 references)

Cairns R D. 2002
Environment and Development Economics 7(2): 207-214

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855 Shebrooke St. W, Montreal, Canada H3A
2T7 <rcairns@leacock.lan.mcgill.ca>

GENERAL

Information access, income distribution, and the Environmental Kuznets Curve

[458] Recent empirical studies have tested the hypothesis of an EKC focusing primarily on the relationship between per capita income and certain types of pollutant emissions. Given the stock-nature of many pollution problems, emissions only partially account for the environmental impacts. Moreover, almost all of the studies have given consideration to little more than income levels as explanatory variables. This paper empirically tests the hypothesis of the EKC existence for a stock-sensitive indicator, that is, the percentage of protected area within national territory. It does theorize that economic growth is a necessary condition in order to address the environmental issues better. But it also stresses that other variables (income distribution, education, information accessibility) may play a fundamental role in determining environmental quality. Contrary to other studies that mainly focus on the calculation of the income level corresponding to the transition point, this paper is more concerned with the calculation of environmental quality corresponding to that transition point, that is, the minimum level of environmental quality that a country is willing to accept. The paper highlights the idea that if the transition point is determined primarily by income level, the social policies determine the level of environmental quality corresponding to that point. (4 figures, 6 tables, 34 references)

Bimonte S. 2002
Ecological Economics 41(1): 145-156

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Embodied pollution in trade: estimating the 'environmental load displacement' of industrialized countries

[459] The present paper sets out to aid in the development of 'environmental load displacement' indicators. Developing the notion

of the 'environmental memory' of physical flows, the authors estimated embodied pollution in trade of 18 industrialized countries with (1) the rest of the world, and (2) the developing countries from 1976 to 1994. The authors found that in the last years of analyses, total imports of Japan, USA, and Western Europe have entailed, in general, larger air pollutant emissions than local exports. The balance of embodied emissions in trade seems to follow an inverted U-shape across time in Japan and Western Europe, and an N-shape in the US. In the period of analysis, Japanese and European environmental terms of trade with developing countries improved (from the Japanese and European point of view), whereas American environmental terms of trade with developing countries deteriorated over time. Although there is no statistical trend between income and embodied emissions in imports in a cross-section analysis, there does seem to be a positive relationship between both variables at a national level. The results suggest that, despite many shortcomings, this type of assessment may shed useful insights on the international aspects of sustainable development. (9 figures, 57 references)

Muradian R, O'Connor M, and Martinez-Alier J. 2002
Ecological Economics 41(1): 51-67

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[460]

Intergenerational equity and sustainability

The paper explores the limitations of conventional economic analysis of intergenerational problems and examines some of the alternatives suggested in the literature. It is argued that proper consideration of future generations has at least three requirements. First, when future costs and benefits are considered, it should be taken into account that they are to be enjoyed by different generations. Second, the sustainability requirement should be adopted. This represents an equity commitment to the future and implies the recognition that future generations have the right to non-deteriorated ecological and economic capacity. The paper studies the ways in which the recognition of these rights might be incorporated into economic evaluation and management. Third, an appropriate institutional network to enforce the recognition of these rights in decision-making processes should be constituted. Its design and necessary functions are also analysed. (1 figure, 60 references)

Padilla E. 2002
Ecological Economics 41(1): 69-83

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Spain <emilio.padilla@uab.es>

Internet resources

Web sites

CO2e.com

www.co2e.com/

CO2e.com has been formed by the Cantor Fitzgerald Group in association with PricewaterhouseCoopers. The web site incorporates both a marketplace and a full suite of online carbon commerce support including a web-based broker-assisted marketplace for trading of emissions reductions, a daily news service, briefings and insights, a specialized search engine, online business and trading tools, and a global register of recognized climate change consultants and experts.

The Carbon Trader

www.thecarbontrader.com/

The Carbon Trader provides reporting, library, and intermediary commercial services for the emerging carbon credit market. Organizations have an opportunity to market carbon dioxide at <www.thecarbontrader.com/auction/auction.htm>.

Climateprediction.com

www.climateprediction.com/

The web site provides a state-of-the-art simulation programme of the climate system, which runs on your PC. By downloading the program you will be contributing to the study of climate change and, in particular, helping to resolve some of the uncertainties in the science of climate change.

EcoCarbon

www.ecocarbon.org.au

The aim of EcoCarbon, a non-profit organization, is to provide industry-based education and training with respect to the Kyoto Flexibility Mechanisms. EcoCarbon provides experience in the trading of GHGs, with a focus on Australian industry, though it does not exclude international participation. The web site contains the latest news and information, related links, and contacts.

ECOLEX: a gateway to environmental law

www.ecolex.org

ECOLEX is an information service on environmental law, operated jointly by UNEP, IUCN (World Conservation Union), and FAO. Its purpose is to build capacity worldwide through providing the most comprehensive global source of information on environmental law. The ECOLEX database includes bibliographic and analytical information on multilateral and bilateral treaties, EU legal instruments, national legislation, and other non-binding policy and technical guidance documents, judicial decisions, and law and policy literature. This information is linked to the full text of the documents, where available.

Emissions Marketing Association

www.emissions.org

The mission of the EMA (Emissions Marketing Association) is to promote market-based trading solutions for environmental management and to serve its membership. The EMA promotes the advancement and application of policy and regulation relevant to market-based emission trading systems.

Greenhouse Gas Pollution Prevention Project – Climate Change Supplement

www.climatechangeindia.com/gep_ccs/index.htm

The programme partners are the Confederation of Indian Industry, Development Alternatives, ICICI, and the Lal Bahadur Shastri National Academy of Administration. The programme aims to build local capacity and create a forum for greater dialogue and technical cooperation on global climate change and clean energy issues between the US and Indian governments, financial, private, and non-government stakeholders. The web site outlines activities, partners and collaborators, project tracking systems, links, and news. The primary objectives of the programme include building institutional capacity, developing GHG mitigation projects, and designing outreach and collaborative activities.

International Emissions Trading Association

www.ieta.org

The IETA (International Emissions Trading Association) is committed to establishing a functional international framework for trade in GHG emission-reductions. The IETA members seek to develop an emissions trading regime that results in real and verifiable GHG emission reductions while balancing economic efficiency with environmental integrity and social equity.

International Utility Efficiency Partnerships, Inc.

http://www.ji.org/index_eng.htm

The purpose of the IUEP (International Utility Efficiency Partnerships, Inc.) is to identify international energy project development opportunities and to support voluntary market-based mechanisms, including joint implementation, the CDM, and emissions trading project investment and development activities. The IUEP has established a programme to solicit, evaluate, and fund project proposals from US utilities and energy companies interested in developing and implementing international projects that avoid, reduce, or mitigate GHG emissions in a credible, creative, and cost-effective manner.

Senter – Carboncredits.nl

www.carboncredits.nl

Carboncredits.nl helps companies investing in renewable energy and energy efficiency in developing countries or in Central and East Europe improve the return on their investments. Through this web site the Dutch government buys the reduction in GHG emissions (carbon credits) that these projects generate, thus creating an additional source of income to boost the economic feasibility of projects and accelerate their implementation.

Mailing lists

Environmental Information Distribution List

The Environmental Information Distribution List is meant particularly for environmental scientists. It will distribute recent information about publications (abstract and source), courses, educational programmes, resource information, workshops, and conferences. To subscribe, e-mail to <listserv@nic.surfnet.nl> with 'subscribe ENVINF-L' in the subject line.

SD-Webworks Discussion Forum

www.sdgateway.net/webworks/discussion.htm

The SD-Webworks Discussion Forum is a service of the Sustainable Development Communications Network. This list has subscribers from around the world who share their strategies for dealing with the challenges of communicating sustainable development using the Internet.

CONSGIS: biological conservation and GIS

The purpose of the CONSGIS list is to foster communication among persons interested in using the GIS (geographic information systems) technology for the conservation of biodiversity. To subscribe to this list, e-mail to <listserv@uriacc.uri.edu>.

Calendar of events

Conferences, congresses, seminars, symposiums, and workshops

Washington, DC, USA
6-11 June 2002

Healthy Ecosystem, Healthy People: Linkages between biodiversity, ecosystem health and human health
International Society for Ecosystem Health, Faculty of Medicine and Dentistry, Health Sciences Addition, H041, The University of Western Ontario, London, ON N6A 5C1 Canada

Fax +1 519 661 3737 • *Tel* +1 519 661 2111 Ext. 86223
Web site www.ecosystemhealth.com/hehp/

Palampur, India
7-9 June 2002

4th World Congress on Environment Management: Sustainability through Good Governance
WCEM Secretariat (India), M-64 Greater Kailash II, New Delhi - 110 048, India

Fax +91 11 645 2802, 620 5301 • *Tel* +91 11 641 7997, 642 0845
E-mail iod@vsnl.com • *Web site* www.wef.org.uk

University of Leeds, UK
1-2 July 2002

Corporate Social responsibility and Environmental Management Conference
Elaine White, Conference Coordinator, ERP Environment,
PO Box 75, Shipley, West Yorkshire BD17 6 EZ, UK

Fax +44 1274 530409 • *Tel* +44 1274 530408
E-mail elaine@erpenv.demon.co.uk
Web site www.erpenvironment.org

London, UK
8-9 July 2002

JI and CDM 2002: Monetising Carbon Credits in Emerging Economies
Environmental Finance Conferences, Fulton Publishing, 22-24 Corsham Street, London NI 6DR, UK

Fax +44 20 7251 9161 • *Tel* +44 20 7251 9151
E-mail info@environmental-finance.com

Kiev, Ukraine
10-11 July 2002

International Conference on Investments and Climate change: opportunities for Ukraine
Mr Alex Khomenko, Climate Change Initiative Center, Ukraine

Fax + 38 44 253 5068 • *Tel.* +38 44 253 5177, 253 7663
E-mail akhomenko@climate.org.ua
Web site www.climate.org.ua

Madrid, Spain
15-18 July 2002

Quaternary Climatic Changes and Environmental Crises in the Mediterranean Region
Departamento de Geología. Edificio de Ciencias, Campus Universitario, Universidad de Alcalá, 28871 Alcalá de Henares, Madrid, Spain

Fax +34 91 885 50 90 • *E-mail* climatic.changes@uah.es

Stockholm, Sweden
12-15 August 2002

2002 Stockholm Water Symposium
Stockholm International Water Institute, Sveavägen 59,
SE-113 59 Stockholm, Sweden

Fax +46 8 522 139 61 • *E-mail* sympos@siwi.org

Johannesburg, South Africa
26 August-4 September 2002

World Summit on Sustainable Development
Johannesburg Summit Secretariat, Division for Sustainable
Development, United Nations Department of Economic and
Social Affairs, Two United Nations Plaza, DC2-2220, New
York, NY 10017, USA

Web site www.johannesburgsummit.org

Shijiazhuang, China
15-19 September 2002

Environmentally Sustainable Agriculture for Dry Areas for the 3rd Millennium
Ms Catherine Vachon, Lethbridge Research Centre Agriculture
and Agri-Food Canada, Lethbridge, Alberta T1J 4B1, Canada

Fax +1 403 382 3156 • *E-mail* vachonc@em.agr.ca
Tel. +1 403 317 2257
Web site res2.agr.ca/lethbridge/hebei/confindex.htm

Manchester, UK
16-17 September 2002

Business Strategy and the Environment Conference
ERP Environment, PO Box 75, Shipley, West Yorkshire, BD17
6 EZ, UK

Fax +44 1274 530409 • *E-mail* elaine@erpenv.demon.co.uk
Tel. +44 1274 530408 • *Web site* www.erpenvironment.org

Wengen, Switzerland
25-27 September 2002

International Workshop on Quantifying Terrestrial Carbon Sinks: Science, Technology and Policy
Professor Martin Beniston, Director, Department of Geo-
sciences, University of Fribourg, Perolles, CH-1700 Fribourg,
Switzerland

E-mail martin.beniston@unifr.ch
Web site www.unifr.ch/geoscience/geographie/EVENTS/Wengen/02/Wengen2002.html

Kyoto, Japan
1-4 October 2002

Sixth International Conference on Greenhouse Gas Control Technologies
GHGT-6 Secretariat, Norifumi Matsumiya, Research Institute
of Innovative Technology for the Earth (RITE), Planning and
Survey Group, 9-2 Kizugawadai, Kizu-cho Soraku-gun, Kyoto
619-0292, Japan

Fax +81 774 75 2314 • *E-mail* ghgt@rite.or.jp
Tel. +81 774 75 2301 • *Web site* http://www.rite.or.jp/GHGT6/

Kuala Lumpur, Malaysia
14-18 October 2002

International Conference on Urban Hydrology for the 21st century
Secretariat, International Conference on Urban Hydrology for the
21st century, The Regional Humid Tropics Hydrology and Water
Resources Centre for Southeast Asia and the Pacific (HTC Kuala
Lumpur), Department of Irrigation and Drainage Malaysia,
Km.7, Jalan Ampang, 68000 Ampag, Kuala Lumpur, Malaysia

Fax +603 4256 1894 • *Tel* +603 42552 502
E-mail icuh2002@did.moa.my
Web site htc.moa.my/htc/icuh2002/icuh2002.html

Qingdao, China
15-18 October 2002

2nd GLOBEC Open Science Meeting: Comparative Ecosystems and Climate Change
GLOBEC IPO, Plymouth Marine Laboratory, Prospect Place,
Plymouth PL1 3DH, UK

Fax +44 1752 633101 • *E-mail* globec@pml.ac.uk
Web site www.pml.ac.uk/globec/main.htm

Cairns, Australia
21-25 October 2002

International Ecotourism Conference
Tony Charters, Conference Convener, C/- Tourism
Queensland, GOP Box 328, Brisbane QLD 4001

Fax +61 7 3535 5445 • *Tel.* +61 7 3535 5493
E-mail tony.charters@tq.com.au
Web site www.ecotourism-australia.info/conf2002/index.htm

New Delhi, India
23 October-1 November 2002

COP-8: Eighth Conference of the Parties to the UNFCCC
UNFCCC Secretariat, PO Box 260 124, D-53153 Bonn, Germany

Fax +49 228 815 1999 • *E-mail* secretariat@unfccc.int
Web site www.unfccc.int

Bishkek, Kyrgyzstan
29 October-1 November 2002

Bishkek Global Mountain Summit
Ms Andrei Iatsenia, UNEP Mountains Programme Coordinator,
Technical Secretariat for the BGMS, UNEP-WCMC and UNEP
Regional Office for Europe, 15 Rue des Anemones, 1219
Chatelaine-Geneva, Switzerland

Fax +41 22 917 8036 • *Tel.* +41 22 917 8273
E-mail iatsenia@unep.ch
Web site globalmountainsummit.org/Home_Page.html

Toulouse, France
12-15 November 2002

Workshop of the Atmospheric Model Intercomparison Project: Towards innovative climate model diagnostics

E-mail pgleckler@llnl.gov • *Web site* www.cnrm.meteo.fr/amip2/

Brussels, Belgium
12-15 November 2002

Fourth European Conference on Applied Climatology: Climate-related risk assessment and sustainable development in the 21st century
ECAC-2002, c/o Royal Meteorological Institute of Belgium,
Avenue Circulaire 3, B-1180 Brussels, Belgium

E-mail ECAC-2002@oma.be • *Web site* www.meteo.be/ECAC-2002/

Texas, US
18-22 November 2002

WOCE and Beyond: Achievements of the World Ocean Circulation Experiment
US WOCE Office, Department of Oceanography, 3146 TAMU,
College Station, TX 77843-3146, USA

Tel 1-979-845-1443 • *E-mail* woce2002@tamu.edu
Web site www.woce2002.tamu.edu/wocebeyond.html

London, UK
21-22 November 2002

Climate Policy for the Longer Term: From here to where?
The Royal Institute of International Affairs, Chatham House,
10 St James's Square, London, SW1Y 4LE, UK

Fax +44 20 7321 2045, 7957 5710
Tel. +44 20 7957 5700, 7957 5754
E-mail conferences@riia.org, contact@riia.org
Web site www.riia.org

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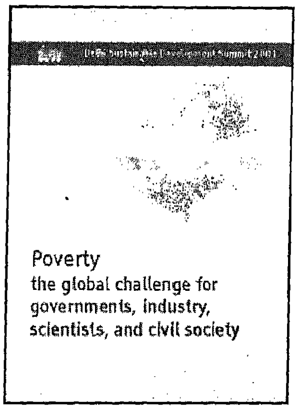
Poverty*: the global challenge for governments, industry, scientists, and civil society*



Delhi Sustainable Development Summit 2001

Poverty
the global challenge for
governments, industry,
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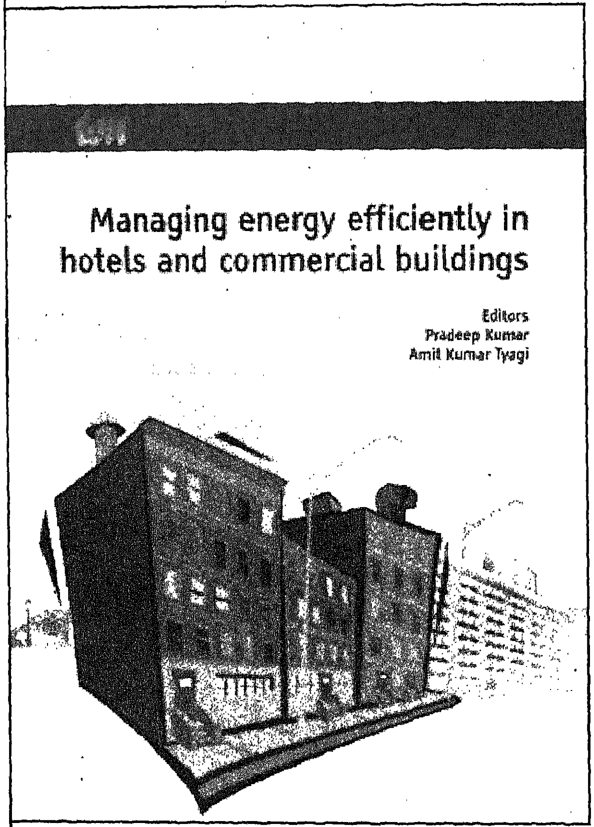

Managing energy efficiently in hotels and commercial buildings

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Increased development of housing and commercial buildings has imposed immense pressure on our dwindling energy sources. The exponential increase in the costs of different forms of energy has led to the growing importance of energy conservation as a means of cutting energy costs in buildings. Studies have revealed that incorporation of energy-efficiency concepts reduces energy use in new buildings by 40% of that in conventional buildings, and in existing buildings by 20% by suitable retrofit applications.

Managing energy efficiently in hotels and commercial buildings would enable readers to understand the energy consuming systems in commercial buildings and equipment used in these systems, and how to find out their operating efficiencies. This book also helps in finding out areas where energy wastage takes place and suggests appropriate energy-saving measures to optimize energy use in those areas. Case studies provided at the end of each chapter would help better understand what has been discussed in the chapter.

This publication is primarily targetted at professionals involved in energy management and energy auditing of commercial buildings, practising system designers, energy consultants, students pursing degree in energy systems, and policy makers responsible for developing and enforcing good energy practices in their organizations.

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